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The Course of Oil

By K. C. SCLATER

Allowable Increase Unjustified For the first time, acreage has been included in the proration order for the East Texas field. Regardless of whether or not the method of applying the acreage factor is a sound one, its inclusion after all these years is significant. It is a signal recognition of engineering principles and emphasizes the increasing consideration being given to reservoir conditions as a basis for prorating a field.

Offsetting this forward step is the raising of the top allowable for the field. This increase, for which there seems no justification, is certain to accelerate the decline of reservoir pressure and draw nearer the day when wells now flowing will have to be pumped. The flowing life of the entire field will be materially shortened; to what extent the next month or two will tell.

Compact Handles Crisis Last month's fiasco in reducing crude prices brought on a crisis in which the Interstate Oil Compact Commission demonstrated its ability to act quickly and intervene in an emergency, thus averting a serious setback to stability in the industry. By concerted action the oil-producing states, it was shown, were able to exercise a conciliatory influence that proved very effective. The ensuing developments were an outright refutation of the need for Federal interference.

Although the whole affair was an unfortunate occurrence—unfortunate in that it may be seized upon by proponents of Federal control of the oil industry —it has strengthened the position of the oil states, showing that by their united efforts they can control effectively oil production in their respective states to the ultimate benefit of both the industry and the general public.

At a meeting in Fort Worth Friday, September 15th, the Interstate Oil Compact Commission went on record recommending that all states limit production to estimates of demand as forecast by the United States Bureau of Mines. The statement issued said in part:

"The Oil States have demonstrated that they can act and will act when needed to prevent over-production of oil and prevent physical waste in the production of oil and gas within the confines of their respective Sovereign States.

"The Oil States naturally each wish to produce as much oil as they can without waste. We all wish to sell as much oil as we can.

"But we do know that if each State tried to produce all the oil it could produce and did so produce as much as they could, there would be vastly more oil on top of the ground than could be consumed or marketed and further that great preventable waste would occur.

"We recommend that all the compacting Sovereign oil producing States limit their production to the figures as issued by the Bureau of Mines in the future.

"We feel that the U. S. Bureau of Mines' estimates of market demand are being constantly corrected and brought up-to-date.

"We recognize that there is a lag in the reflection of economic trends in the Bureau of Mines' estimates of future demand but we also understand that in the long pull, and over a period of time, the Bureau of Mines figures are the best yardstick at hand and therefore we renew our recommendation of the United States Bureau of Mines forecasts of market demand as our guide in fixing allowables in the future.

"We have learned by experience that the recovery of oil will positively be increased by controlled production through the application of sound engineering principles to the production of oil and gas.

"Our studies of the physical effect of the shut-down assure us that pressures were rebuilt and many wells that were formerly on the pump have again started to flow naturally.

"We simply get together under consent of Congress and discuss our common problems as representatives of Sovereign States for the sole purpose of preventing physical waste. Each state's representatives go home to their state and act as they see fit under their own respective state laws.

"Our meeting has been harmonious and we all are happy over the present situation and express our complete confidence in every state to carry on their waste prevention measures and preserve our American form of government and keep the control of our oil production close at home and close to the people of the states.

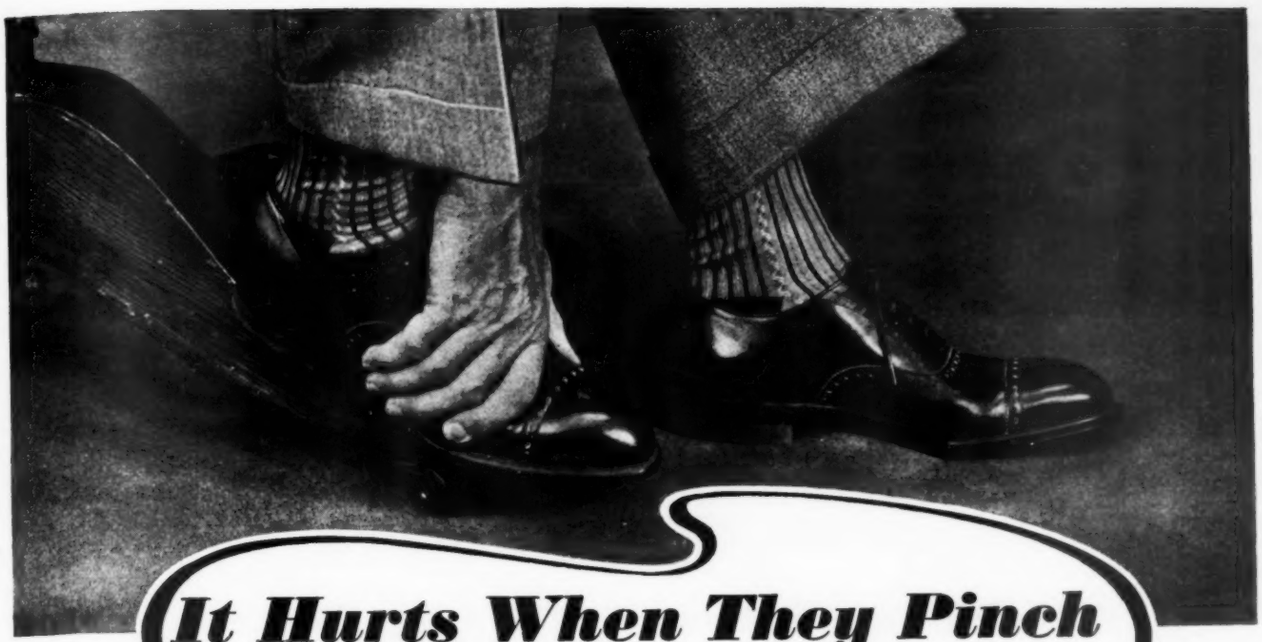
"We earnestly call upon all engaged in the oil industry to consider the great progress that the oil states have made in preventing physical waste and ask them to contemplate calmly and deliberately the fine position the oil industry now occupies. We invite your continued serious co-operation.

"There is no other industry so thoroughly under control to prevent waste. This control is lodged close to the people."

War and Oil Should war in Europe continue for any length of time, a sharp demand in petroleum and its products is inevitable. It is quite likely, too, that the petroleum industry of the United States would be called upon to supply a substantial volume of the oil to fill this demand. In that case the lessons learned in the past with regard to the wisdom of controlling production should be kept in mind.

It should be determined whether or not the oil industry can supply this demand under sound proration practice, which assumes that each field would be allowed to produce only *at the maximum rate dictated by reservoir conditions.*

If the volume of oil produced be based primarily on reservoir conditions and according to sound engineering principles, it would make all the more imperative the need, should there be such, for increasing petroleum reserves and so stimulate the search for them; for to produce fields at their maximum rate without regard to reservoir conditions may do irreparable harm to the oil resources of the Nation.



It Hurts When They Pinch

Just as a tight shoe hurts the foot, so a "misfit" groove in a sheave or drum causes damage to wire rope. In one case, comfort is sacrificed—in the other, economy.

The illustration below shows a sheave groove that has been worn down fully ½ of an inch. The worn part of the groove is narrower than was the original groove contour—due to the rope also having been reduced in diameter by wear. As the proper size gauge does not go to the bottom of this worn groove, a new full size rope put on this sheave in its present condition would be severely pinched and deformed.

You will get longer rope service, and therefore greater economy, by using sheaves and drums with grooves of correct design and size. They should be large enough for the wire rope to fit into them easily without binding on the sides, but not too large, as such a groove will not give proper support to a rope.

When grooves wear deeper and narrower . . . or when the tread becomes corrugated, they should be regrooved. Oftentimes it will pay to install new sheaves. Make it a rule to check your grooves for size and condition at regular intervals—and especially before putting on a new rope.

The recommended diameter of groove for any given size rope is the nominal diameter plus a certain necessary clearance. Anything larger will not give adequate support to all ropes, and anything smaller will cause some ropes to be pinched. These groove diameters for various size ropes are as follows:

Nominal Diameter (d)	Proper Groove Diameter
0—3/4	d + 1/16
13/16—1-1/8	d + 5/64
1-3/16—1-1/2	d + 3/32
1-9/16—2-1/4	d + 1/8
2-5/16 & up	d + 3/16

This advertisement is published for the purpose of helping all wire rope users obtain safer and more economical service from their wire rope

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« « HIGHLIGHTS IN OILDOM » »

Humble Wins Allowable Suit

The East Texas allowables of the Humble Oil and Refining Company and the Rowan and Nichols Company were increased 44 percent by a decision of Federal Judge Randolph Bryant, who also ordered the Federal Tender Board at Kilgore to issue tenders on the oil produced.

Rowan and Nichols Company began the litigation for increased allowables, suing the Texas Railroad Commission in a three-judge Federal Court in the Western District of Texas at Austin to obtain 144 percent of its then existing allowable. The court granted the increase. The Humble Oil and Refining Company filed a suit in Federal Court at San Antonio and received a favorable decision. The Federal Tender Board, however, rejected four Humble tenders on grounds that the oil was contraband in the meaning of the Connally Act.

Judge Bryant held that the effect of the tender board's contention was to admit that judgment should be granted for the plaintiff companies if the court should find, as a matter of law, that oil produced in accordance with the three-judge court's order was legal and not contraband. On this basis Judge Bryant ruled the oil was legal.

The tender board had held that the San Antonio court order did not show on its face that it applied to the Federal Tender Board or that the board was a party to the suit.

●

Federal Examiner Sent to Michigan

John I. Watson, examiner with the Federal Tender Board No. 1 at Kilgore, Texas, has been transferred to Lansing, Michigan, by Secretary of the Interior Ickes to head the investigating office established there by the petroleum conservation division of the oil administration. Secretary Ickes stated that the Michigan set-up is similar to that established by the federal government in Louisiana, that is, the government's efforts will be directed to investigating whether there are violations of the Connally hot oil act in shipments of oil or petroleum products from Michigan fields.

The Connally act prohibits shipment in interstate commerce of oil or oil products produced in violation of the conservation laws of a state. The only tender board maintained by the federal government for the issuance of oil shipment permits is at Kilgore, Texas, but offices for purposes of investigation are established in Louisiana and now in Michigan. The latter state recently adopted a conservation law.

●

Proration Formula For East Texas

Effective September 14, a new top allowable for the East Texas field has been assigned by order of the Texas Railroad Commission. On the basis of 5-day-per-week production, 685,000 bbl. daily will be allowed, an average of approximately 490,000 bbl. per day on a 7-day-per-week basis. This schedule is expected to govern throughout the remainder of September and all of October.

The commission's order adopts substantially all of the elements of the formula proposed by J. S. Hudnall, Tyler, Texas, in testimony before the commission. The proration formula provides for the allocation of that portion of the field allowable remaining after 20 bbl. per day has been assigned to each well in the field, according to the ratio of a lease's average hourly potential times average thickness of saturated Woodbine formation times average bottom-hole pressure to the product of these factors for the entire field.

Illinois Independents Favor Oil Legislation

Members of the Illinois Oil Producers' Association early this month sent a message to Governor Henry Horner requesting a special session of the state legislature to consider oil legislation. The message, signed by John Pugh, president of the association, declared that fair and reasonable oil conservation legislation would eliminate the waste of one of the state's great natural resources, establish an important industry, and contribute materially to the welfare and economic recovery of the state.

●

Increase in East Texas Pressure

Engineers of the Texas Railroad Commission report a substantial increase in bottom-hole pressure in East Texas wells during the recent shut-down. Engineering department records show that pressure increased 31.39 lb. between August 12 and 22. The shut-down began August 15. Pressures are not so exactly measured in other fields in the state, but engineers assert that the same beneficial results could be presumed in water-driven fields.

●

Oil Exports Declined First Six Months

Exports of petroleum products from the United States during the first six months of the year declined in value to $170,212,000. This was $19,342,000 less than shipped during the similar period of 1938, according to a report of the Metals and Minerals Division of the U. S. Department of Commerce. Principally responsible for this decline was the drop in exports of crude oil of $13,958,000 and reductions of $3,830,000, $2,237,000 and $1,357,000, respectively, in exports of gasoline, kerosene, and gas oil. Only lubricating oils and residual fuel oil experienced larger foreign sales, increasing by $1,774,000 and $265,000 over last year.

Exports of crude petroleum declined 13 percent, from 40,176,000 to 34,949,000 bbl.

●

Large Oil Well Reported Found in Greece

A large oil producer and another well making 20,000,000 cu. ft. of gas per day have been discovered in Greece by George Helis, Louisiana oil operator. The reports state that Helis brought in an oil gusher at Kyllenea and the gas well at Katakolon, the pressure in the latter being great enough to blow the tools from the hole. The oil has been partly shut-in and is awaiting the arrival of American engineers to bring it completely under control.

●

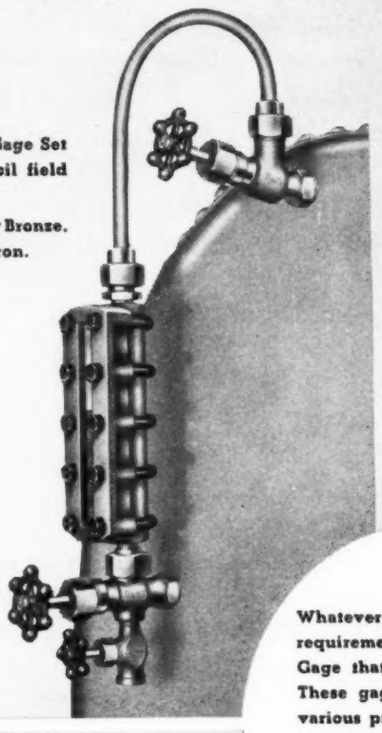
Oil Investigation To Begin in October

House Resolutions 290 and 291, providing for an investigation of the production, storage, transportation, refining, and sale of petroleum and its products have been adopted by the United States Congress. The investigation has been authorized primarily in preparation for consideration of the Petroleum Conservation Bill of 1939. The sub-committee in charge of the investigation is composed of Congressman Cole of Maryland, chairman; Congressman Kelly of Illinois, Congressman Pearson of Tennessee, and Congressman Wolverton of New Jersey.

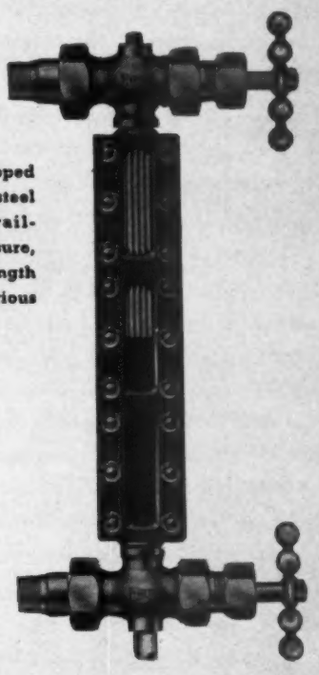
The investigation likely will begin the second week in October, according to Chairman Cole. The first hearing will be in Washington, succeeded by hearings in Illinois, Louisiana, and perhaps on the West Coast.

A PENBERTHY GAGE
FOR EVERY PURPOSE

All Penberthy Gages conform with A.S.M.E., Federal and State requirements when used for pressures specified by their respective codes.



Reflex Water Gage Set designed for oil field boilers.
Type A—Navy Bronze.
Type B—All Iron.

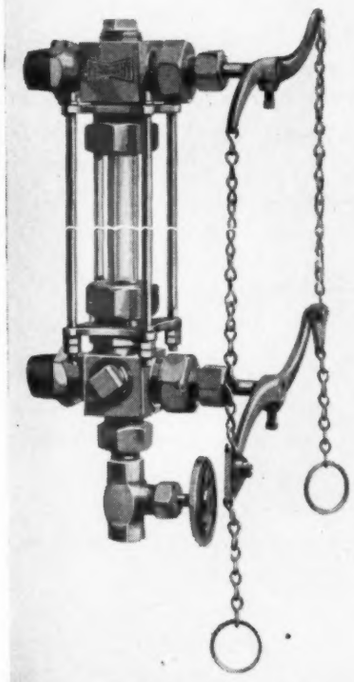


Reflex Gage equipped with drop forged steel gage valves. Available for any pressure, temperature or length required and various liquids.

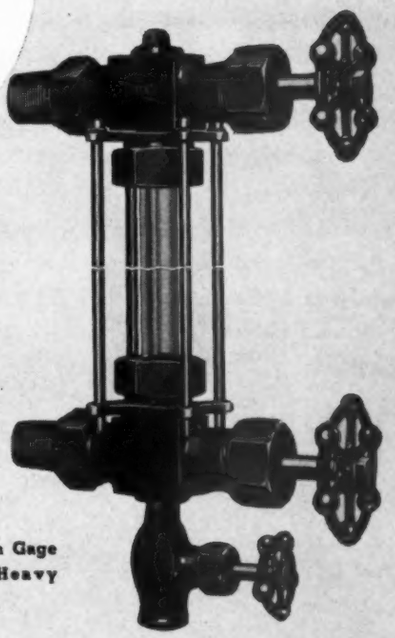
Whatever your liquid level gage requirements, there is a Penberthy Gage that will meet your needs. These gages are suitable for the various pressure and temperature requirements of the oil industry. Write for a copy of new catalog.

Supply houses everywhere stock Penberthy liquid level gages.

PENBERTHY PRODUCTS



Navy Type Gage
Extra Heavy Bronze



All Iron Gage
Extra Heavy

PENBERTHY INJECTOR COMPANY Manufacturers of QUALITY PRODUCTS Since 1886
DETROIT, MICH. • Canadian Plant, Windsor, Ont.

Major Pipe Line Activities

CONSTRUCTION has been completed by Cities Service Gas Company of approximately 40 miles of 8-in. pipe line connecting the Cunningham field, Kingman County, Kansas, to the company's distribution system at Hutchinson, Kansas.

Level terrain and absence of rock, except in the crossing of the Ninnescah River, facilitated comparatively easy construction, all being done by the company's own personnel and equipment.

Single-length (20-ft.) joints of pipe were hauled to pipe yards along the right-of-way, then welded in 40-ft. lengths before being assembled into the line.

•

The General Gas Pipe Line Corporation has applied to the Federal Power Commission for reinstatement of its petition to construct 180 miles of natural gas pipe line and 40 miles of laterals over a route from central Kentucky to central Indiana. The project, if approved and constructed, will provide employment for about 1500 men and will require the expenditure of approximately $4,500,000.

•

On July 18, 1939, the Federal Power Commission granted a certificate of public convenience and necessity authorizing the Louisiana-Nevada Transit Company to construct a 75-mile pipe line to transport natural gas from the Cotton Valley field, Webster Parish, Louisiana, to Okay, Howard County, Arkansas, and a 12-mile extension to Hope, Arkansas, to serve two industrial consumers—a cement plant and a brick works, and to supply gas to the municipal power plant at Hope.

Arkansas-Louisiana Gas Company, an intervener in the original proceedings, has filed a petition asking that the order be rescinded and a rehearing granted. The company asserts it is now serving adequately the territory and the three accounts mentioned and contends that the Commission erred in issuing the certificate in violation of Section 7(c) of the Natural Gas Act.

•

Champlin Refining Company, Enid, Oklahoma, is beginning construction of an additional 280 miles of 6-in. pipe line to obtain additional outlet for gasoline manufactured in the company's Enid refinery. The new line will extend from Superior, Nebraska, 280 miles northeast to a point near Sioux City, Iowa.

Purchase orders have been issued for pipe and for materials required in the construction of a telephone line that will parallel the pipe line.

Champlin's present line, 240 miles long, was one of the early gasoline lines built in the Mid-Continent. The construction of the new line will represent another addition to the total gasoline pipe-line mileage of the country, which is being increased materially by other lines now being constructed.

•

Construction of five miles of 6-in. and ten miles of 4-in. pipe line in New Mexico is nearing completion. Built by the Texas-New Mexico Pipe Line Company, the 4-in. will serve as gathering lines in the Loco Hills field and the 6-in. will be used to transport oil from the field to the company's district pump station at Artesia, Eddy County, New Mexico.

•

Final decision on the construction of the long-proposed oil pipe line from the Turner Valley field, Alberta, Canada, will be delayed at least until October when results of the investigation made by Dr. Charles Camsell will be submitted to the Dominion government of Canada and to British interests that will provide the capital for construction. Dr. Camsell is deputy federal minister of mines and resources.

•

On the Gulf Coast, work has begun on the construction of 42 miles of 8-in. oil pipe line from West Columbia, Brazoria County, to Webster, Harris County, Texas. The line is being built for the Texas Pipe Line Company by Williams Brothers Construction Corporation. The all-welded line will tie-in at Webster to the company's trunk line to the Texas City refinery.

•

In addition to the line now being built by Stanolind Pipe Line Company, another line from the Cayuga field, Anderson County, Texas, may be constructed by this company, according to present plans. Now under construction are 19 miles of 6-in. and 16 miles of 8-in. oil line from Stanolind's Bullock station near Mexia, Limestone County, to the Cayuga development. The proposed line will connect the Cayuga and Long Lake fields. Crude oil gathered in Cayuga by Pan American Pipe Line Company and tendered to Tide Water-Associated Oil Company for transportation from the field will be tendered to Stanolind by the gathering company after the line construction is completed.

You can't judge PISTON RINGS by looks

. . . any more than you can judge tires

ONE tire is good for only 15,000 miles; another is good for 40,000 miles. Yet you can't tell the difference by looking at them. There are **invisible** ingredients in the good tire that account for its vastly superior performance.

The same is true of piston rings. You can't judge their performance ability by looks. The marked superiority of COOK'S Rings in the vital matter of performance, originates in the fact that they are **engineered expressly** to meet internal combustion engine and compressor conditions — a procedure made possible by COOK'S specializing in custom-made rings for this and associated service requirements.

From the basic raw material used exclusively in COOK'S Rings, followed by foundry practices far too costly for use in producing ordinary rings, come the hidden properties that give COOK'S Rings their unequalled ability to resist wear, to retard cylinder wear and to outlast ordinary rings by a wide margin.

The tough, durable COOK'S GRAPHITIC IRON — the result of years of intensive research and testing before its introduction nearly 20 years ago — is largely responsible for the wide-spread and ever increasing use of COOK'S Rings by equipment builders and operators who appreciate that performance counts, and that the best rings are ultimately the most economical.

Among the other exclusive features you get in COOK'S Rings are special designs such as the COOKTITE Sealing Ring that positively prevents blow-by, and the revolutionary new TINIZED Surface Treatment consisting of a coating of anti-friction metal, up to .002" thick, that eliminates initial ring and cylinder scuffing, promotes rapid development of mirror-like wear-resisting skins on both cylinder and ring surfaces, and keeps on retarding wear even after thousands of hours of operation.

Specify COOK'S GRAPHITIC IRON Piston Rings on your next order. They fit existing grooves and the cost is only slightly more than ordinary rings — a difference that is made up many times in improved performance and prolonged ring and cylinder life. If you're in doubt as to the most efficient ring set-up for your particular engine or compressor, ask us for recommendations.

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COOK'S GRAPHITIC IRON
Piston Rings
"Sealing Pressures" Since 1888

Activities in the Oil Fields

THE first oil well for the State of Mississippi has been brought-in by Union Producing Company in its No. 1 Woodruff about 30 miles northwest of Jackson in Yazoo County. The well was drilled to a total depth of 4560 ft. and 7-in. oil string set at 4540 ft. After being washed by clear water the well began flowing on September 5 without swabbing. During the initial test, through ¼-in. choke, an estimated 10 bbl. of oil per hour was produced. The well had not completely cleaned itself, however. The following day, on a 12-hour test, the well flowed 93 bbl., tubing pressure being 305 lb. and casing pressure 240 lb.

Production is from about 10 ft. of broken sand and sandy lime formation at the base of the Selma chalk.

●

Western Gulf Oil Company has successfully completed No. 1 KCL-Panhandle to discover a new field in Kern County, California. The well is 10 miles southeast of the Ten Section field and 6 miles southeast of the Coles Levee field.

Drilled to a total depth of 10,178 ft., the well was swabbed-in and produced 1000 bbl. of oil and 10,000,000 cu. ft. of gas per day. The oil tests 50 gravity. Production is from the Stevens zone.

●

Bruce C. Tetters has completed a test on the closed dome of the Dewey Dome field, Weston County, Wyoming, which flowed 10 bbl. of oil per day. The well, No. 1 State, was drilled to a total depth of 1020 ft., and is producing from the Sundance formation.

This test is two and one-half miles northwest of the discovery well, drilled in 1936, which is the only other well producing in the area. The new well is considerably higher structurally than the discovery well and is expected to stimulate drilling in the area.

The Texas Company's No. 1 Gerd Peters, a wildcat on the Hilje prospect, southwestern Wharton County, Texas, flowed an estimated 24 bbl. of oil and 587,000 cu. ft. of gas per day through ⅛-in. choke. Tubing pressure was 1400 lb. and casing pressure 1625 lb. Casing was perforated at 5220-30 ft. The oil tests 25 gravity. This well, if it develops into a commercial producer, will open a new field for the Texas Gulf Coast area.

●

Tide Water-Associated Oil Company has completed the second well in the recently discovered Strand area of San Joaquin Valley, California. The new well, Strand KCL E 24-7, was completed at a total depth of 8330 ft. and on a 12-hour initial flow test produced at the rate of 3300 bbl. of oil and 1,650,000 cu. ft. of gas per day. The oil tested 34.6 gravity. The potential of this well is twice that of the discovery well. The Strand area is approximately 14 miles west of Bakersfield.

●

Atlantic Refining Company has opened a new Smackover lime pool near Experiment, Columbia County, Arkansas, with its No. 1 Pine Woods Lumber Company well. The well was drilled to a total depth of 9002 ft. and the 5½-in. casing perforated with 75 shots at 8861-75 ft. On the initial 6-hour test the well flowed 20 bbl. per hour through 18/64-in. choke. Casing pressure was 1150 lb. and tubing pressure 750 lb. The oil tested 45.5 gravity.

●

J. P. Scranton's No. 2 Martinez, a wildcat in Section 132-15S-17E, LaFourche Parish, Louisiana, appears to be another 10,000-ft. discovery for the Gulf Coast of Louisiana. Casing was perforated at 10,127-33 ft. and a drill-stem test taken. The well flowed oil for 45 minutes through ¼-in. choke, the oil testing 39.5 gravity.

AVERAGE CRUDE PRICES

California		Louisana	
Kettleman Hills	$1.19-1.43	Rodessa	$1.05
Playa Del Rey	.80-1.16	Gulf Coast	.79-1.28
Coalinga	.70- .90	North Louisana	.73-1.05
Wilmington	.75-1.21	Illinois	.85-1.05
Montana	.90-1.10	Kentucky	.90-1.10
Wyoming	.35-1.30	Indiana	.95
Colorado	.90- .98	Ohio	
New Mexico	.53- .95	Lima	.90
Texas		Michigan	.70-.97½
North Central	.71-1.03	Pennsylvania	
Panhandle	.67- .96	Bradford	2.00
West Texas	.53- .95	Southwest	1.65
Gulf Coast	.79-1.28	Eureka	1.59
Darst Creek	.96	Buckeye	1.55
East Texas	1.10	Corning	1.02
Talco	.55	Canada	2.10-2.17
Kansas	.60-1.10		
Oklahoma	.60-1.10		
Arkansas	.73-1.05		

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in bbl. of 42 gal. each)

	[1]B. of M. Calculated Requirements (August)	Week Ended Aug. 26, 1939	Week Ended July 29, 1939	Week Ended Aug. 27, 1938
Oklahoma	448,100	165,000	420,400	437,050
Kansas	168,700	89,600	179,400	165,350
Panhandle Texas	.....	18,200	68,700	73,650
North Texas	.....	14,200	93,900	75,600
West Central Texas	.....	6,600	32,400	29,950
West Texas	.....	24,600	242,150	218,950
East Central Texas	.....	4,450	97,600	96,750
East Texas	.....	3,500	373,000	441,200
Southwest Texas	.....	31,400	224,500	239,550
Coastal Texas	.....	57,350	227,450	219,500
TOTAL TEXAS	1,428,100	160,300	1,359,700	1,395,150
North Louisana	.....	28,300	69,000	79,150
Coastal Louisiana	.....	44,100	206,600	188,150
TOTAL LA.	259,300	72,400	275,600	267,300
Arkansas	51,900	29,800	62,950	57,150
Illinois	201,900	310,000	276,300	
Eastern (not incl. Illinois)	106,200	96,000	97,650	161,400
Michigan	54,200	65,300	68,150	49,950
Wyoming	77,100	65,900	66,150	57,800
Montana	16,400	15,950	16,200	12,750
Colorado	3,900	3,950	3,850	3,650
New Mexico	111,000	4,200	109,150	106,950
TOTAL EAST OF CALIF.	2,926,800	1,078,400	2,935,500	2,714,500
California	595,100	612,400	603,600	674,000
TOTAL U. S.	3,521,900	1,690,800	3,539,100	3,388,500

[1]These are Bureau of Mines' calculations of the requirements of domestic crude oil based upon certain premises outlined in its detailed forecast for the month of August. As requirements may be supplied either from stocks, or from new production, contemplated withdrawals from crude oil inventories must be deducted from the Bureau's estimated requirements to determine the amount of new crude to be produced.

Great Pioneers

ILLINOIS, 1803

In July, 1803, Captain Whistler built the first Fort Dearborn, which Indians destroyed in the 1812 massacre. Shortly thereafter public lands, secretly guarding "Black Gold" treasure, sold for $1.25 per acre. In 1818 the "Prairie State," governed under two territorial acts and three constitutions, was admitted to the Union. Here, again, a dauntless pioneer spirit has played the leading role in developing what is now one of the nation's richest oil producing, agricultural and industrial areas.

• NO OPPORTUNITY to pattern after others presented itself to those farsighted individuals who developed the "Prairie State." They were pioneers—they were first—preparing the way for others to follow.

Likewise, there was no opportunity to follow others when, in 1932, Dowell developed Inhibited Acidizing. Since then Dowell has made many other important contributions to the industry—every one the result of pioneering leadership—every one exclusive with Dowell. And although Dowell's contributions have been copied feverishly and frantically, Dowell, in research and accomplishment, retains this pioneering leadership.

One of Dowell's most recent and important pioneering efforts resulted in the development of a de-emulsifying acid, trade-named Dowell "XW". Three characteristics identify "XW": (1) it increases wettability of the acid on oil soaked rock; (2) reduces tendency of either the acid or spent acid to form emulsions with the oil; (3) reduces the surface tension of both the acid and the spent acid solutions.

As these facts become more generally known, ever increasing numbers of operators are availing themselves of Dowell products and services. The results are greater production at less cost and a continuation of this pioneering leadership so vital to the industry.

DOWELL INCORPORATED

General Office: KENNEDY BUILDING, TULSA, OKLAHOMA

Subsidiary of THE DOW CHEMICAL COMPANY

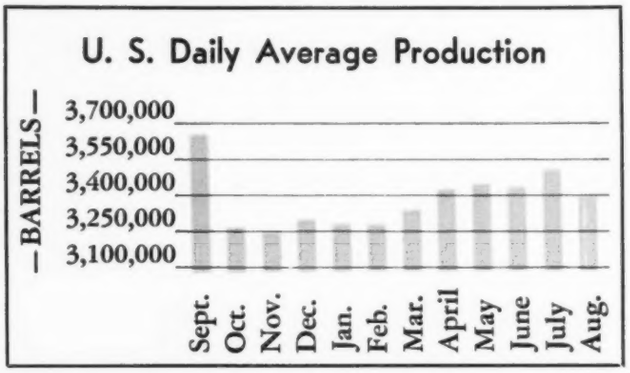
Oil men who attend the Golden Gate International Exposition are cordially invited to visit the Dowell exhibit in The Dow Chemical Company booth.

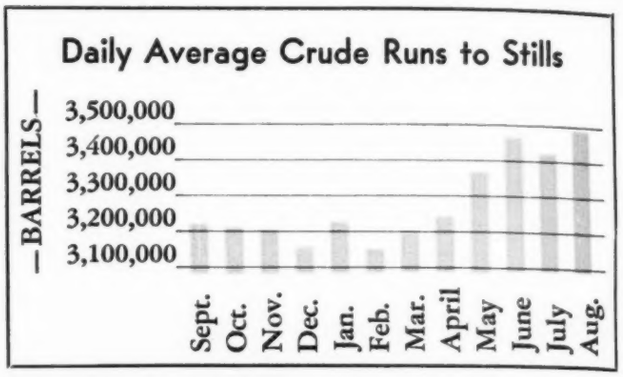
Look to

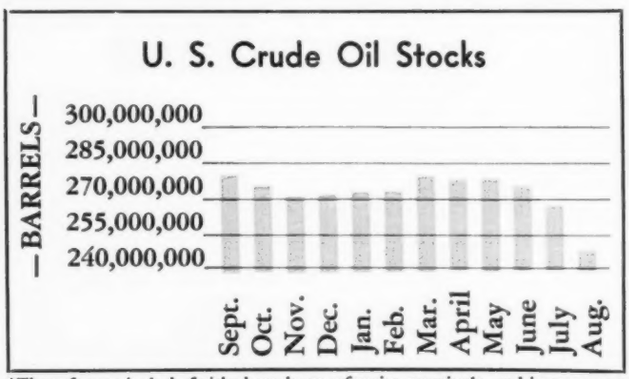
DOWELL

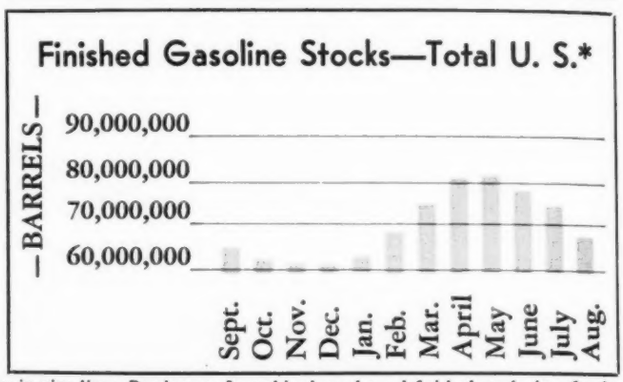
OIL AND GAS WELL
CHEMICAL SERVICE

Petroleum Statistics and Field Activities









*These figures include finished stocks at refineries, terminals, and in transportation in pipe lines. Previous to June this chart showed finished stocks in refineries only. Above statistics by the American Petroleum Institute.

Summarized Operations in Active Fields for August, 1939

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	25	25	2	24	3500-3700	2	40	Rotary
Duval County	31	27	5	15	1554-2900	2	22	Rotary
Ector County	36	36	21	65	3675-4377	2 and 3	32-36	Rot.-Cab.
Panhandle	32	28	15	71	1700-3900	2	40	Rotary
Refugio County	13	9	2	9	4900-5900	2	38	Rotary
Nueces County	28	24	6	12	3922-5878	2 or 3	21-54	Rotary
Winkler County	9	9	2	8	2850-3450	2 and 3	30-38	Rot.-Cab.
K. M. A. Field	29	29	12	42	3730-3935	2	42-43	Rot.-Cab.
Oklahoma								
Oklahoma City	3	2	1	3	6450-6682	3	39	Rotary
Fitts Pool	13	9	2	18	1800-4488	2 or 3	38	Rotary
Kansas								
Russell County	28	23	3	26	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	23	16	5	20	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	11	9	5	16	3290-3518	2	39-42	Rot.-Cab.
Illinois								
Central Illinois	362	289	280	101	1425-4100	2	36-38	Rot.-Cab.
New Mexico								
Lea County	36	35	9	52	3150-4030	3	30-34	Rot.-Cab.
California								
Kettleman Hills	7	7	3	12	8300-8730	3 or 4	40	Rotary
Wilmington	19	19	14	17	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for August, 1939

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1938 (In Barrels)
	August	July	August	July	August	July	August	July	August	July	
Arkansas	28	23	24	23	16	28	15	18	36	34	18,211,617
California	97	91	90	82	123	88	89	90	197	187	249,918,001
Colorado	0	4	0	2	....	....	4	3	29	27	1,371,687
Illinois	362	274	289	219	....	....	280	287**	101	99	23,306,000
Indiana	15	29	11	22	....	....	7	9	62	61	965,900
Kansas	147	127	108	95	129	157	40	49	192	210	58,795,545
Kentucky	68	71	41	32	....	....	11	8	93	94	5,828,650
Louisiana	98	95	72	61	187	99	50	52	166	176	94,941,537
Michigan	127	144	83	92	140	130	18	21	141	133	19,140,966
Mississippi	1	2	0	0	....	....	2	3	8	3	Gas Prod.
Montana	15	21	12	15	....	....	4	5	27	50	4,858,458
New Mexico	53	53	48	41	64	....	16	15	135	131	39,902,263
New York	77*	70*	71*	65*	....	....	4	6	29	30	5,040,600
Ohio	89*	93*	66*	69*	....	....	46	49	156	149	3,292,100
Oklahoma	190	176	125	116	179	185	41	45	311	348	171,312,098
Pennsylvania	192*	208*	184*	190*	....	....	....	....	....	....	17,431,500
Texas	756	959	532	664	819	938	291	317	997	1094	473,304,662
West Virginia	63	54	50	46	....	....	23	29	124	125	3,700,375
Wyoming	17	13	15	9	....	....	5	6	71	73	19,005,638
Total	2395	2507	1821	1843	1657	1625	946	1012	2875	3024	1,206,827,597

*Includes water-intake and pressure wells.
**Includes 233 rigs standing and 54 rigging-up.

Pumping Yesterday

GAS-LIFTING TODAY

Oil industry Engineers have definitely accepted the NIXON SURFACE CONTROL GAS LIFT SYSTEM as the most efficient and economical means of lifting fluid. This is attested by the fact that, since it was offered to the industry, approximately 700 installations have been made, a great number of which have replaced standard pumping rigs.

Every installation is conclusive proof that the Nixon Gas-Lift System is a money saver. Records show all costs . . . original, installation, operation, maintenance . . . are MUCH less than other methods. Down time from all causes is under 2%. Large or small volumes of fluid are raised at lowest cost.

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EXCLUSIVE GULF COAST DISTRIBUTORS FOR: Wilson-Snyder Pumps; American Cable Tru-lay Pre-formed Wire Rope; Kewanee Boilers; Sievers Reamers; Drift Meter, Jr.; Gray Swivel; Nixon Surface Control Gas Lift; Nixon True-Taper Slip and Spider; Bowen Pack-Off and Releasing Drill Pipe Overshot; Douglas Weight Indicator.

OIL & GAS WELL SUPPLIES

Complete line of Fishing Tools and Service

HOUSTON, TEXAS

BRANCH STORES:
TEXAS: Gladewater; Barbers Hill; Bay City; Alice; Victoria; Corpus Christi; Benavides; Monahans.
LOUISIANA: Rodessa; Lake Charles; New Iberia; Gretna; Shreveport.
ARKANSAS: Magnolia; Arkansas City.
SALES OFFICES—Tulsa, Oklahoma; Dallas, Texas.

Activities in Refining

Percent Refining Capacity Operated

Western Division, 70.4 Percent **Central Division, 79.5 Percent** **Eastern Division, 92.0 Percent**

THE Corpus Christi Corporation has completed additions to its recycling plant in the Stratton field, Texas, involving the expenditure of about $125,000. The new equipment includes three 125-hp. superheater boilers to operate at a pressure of 300 lb., and to serve the boilers two feedwater pumps have been installed.

A new 30-tray stabilizer column for operation at 300-lb. pressure, three stabilizer feed and reflux pumps, eight stabilizer heat exchangers, and five atmospheric reflux condensers have been added to existing equipment.

Other equipment installed includes the following:

Centrifugal water pumps direct-connected to steam turbines. The installation consists of two turbines, each driving three pumps.

A calcium chloride injection pump of the outside plunger type.

A pump house measuring 22 ft. by 50 ft. and a boiler house measuring 28 ft. by 48 ft.

A dewatering tank, 30 in. I.D. by 12 ft. long, fabricated of 2½-in. plate and designed for 2500-lb. working pressure.

A stabilizer feed tank, 10 ft. 6 in. by 40 ft., designed for 100-lb. working pressure.

An 8-bay cooling tower.

Steam condenser and classifier.

Calcium chloride evaporator and concentrator.

Reboiler and shell.

Two 2500-bbl. gas-to-gas heat exchangers on the incoming gas.

These installations will increase the production of the plant by 200 bbl. per day by making it possible to operate at a temperature of approximately 20°F. instead of 65°F. through injection of calcium chloride, which lowers the temperature at which hydrates form. Officials of the company now propose to add another 600-hp. angle-type compressor and to drill two more producing wells, which would increase the production of the plant to 1500 bbl. per day.

Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended August 26, 1939

A.P.I. Figures
(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Average Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
East Coast	100.0	578	94.0	20,230	22,595
Appalachian	85.9	112	87.5	3,198	683
Ind., Ill., Ky.	89.5	487	94.7	11,433	7,554
Okla., Kans., Mo.	81.6	260	76.0	6,167	4,550
Inland Texas	50.3	115	72.3	1,638	2,318
Texas Gulf	90.0	848	89.3	8,220	13,291
La. Gulf	97.6	137	85.6	1,934	3,424
No. La. & Ark.	55.0	41	74.5	467	917
Rocky Mt.	54.2	47	73.4	1,110	675
California	90.0	502	67.4	14,058	94,722
Reported	86.0	3,127	83.8	68,455	150,729
Estimated Unreported	.....	348	.....	5,020	3,230
*EST'D TOTAL U. S. AUG. 26, '39	.....	3,475	.....	73,475	153,959
*EST'D TOTAL U. S. AUG. 19, '39	.....	3,575	.....	74,738	152,082
U. S. B. of M. *AUG. 26, '1938	.....	**3,269	.....	71,893	146,328

*Estimated B. of M. basis. **August, 1938, daily average.

A 1000-bbl. refinery is under construction at Alamosa, Colorado, by the William E. Hughes Estate, to process crude oil from the Gramps pool, Archuleta County. A new company, the Gramps Oil and Refining Company, has been organized by the estate to operate the plant. Equipment will include a Dubbs cracking unit.

●

The 4000-hp. recycling plant of the Coastal Recycling Corporation now under construction at Agua Dulce, Texas, will be equipped with Clark angle-type compressors in the new 8-cylinder, 800-hp. size. Five of the units have been ordered.

●

The Shell Oil Company has purchased seven 600-hp. Clark angle-type compressors for installation in its Seagraves, Texas, gasoline plant.

●

Tide Water-Associated Oil Company and the Seaboard Oil Company have awarded a contract to the Frick-Reid Corporation, Tulsa, Oklahoma, for a new recycling plant in the Cayuga field, Texas. The plant will be of the Vaughan type and will have a capacity of 40,000,000 cu. ft. of gas per day. The two companies already have a recycling plant in operation in the field, as well as one under construction in the Long Lake field.

●

A catalytic polymerization plant will be installed at the Toledo, Ohio, refinery of the Standard Oil Company of Ohio as a part of an enlargement program that will involve the expenditure of $100,000. The contract has been awarded to the M. W. Kellogg Company.

●

The Taxman Oil Company, a new corporation, has in the process of construction a 1500-bbl. refinery, situated on the Mississippi River near Rock Island, Illinois.

This Industry of Ours

AN INSIDE LOOK AT THE OIL INDUSTRY AND THE LOT OF THOSE WHO SERVE IT

By NORTH BIGBEE

Part 1

Oil's Contribution to Government and to the Well-being of Human Society

This is the first of a series of four articles on the oil industry and its employees. Next month's article will deal with the opportunities for advancement that petroleum offers its employees, and safety work in the oil industry.

IT was in the bearded 1860's, a few months after a fumbling iron finger at Titusville had opened America's treasure chest of petroleum.

One of those who had helped, in Colonel Drake's famous well, to find oil in Pennsylvania's grass roots, carried some of the dark smelly fluid to a European chemist. After the chemist analyzed it he rushed back in great excitement to the early oilman.

"If that oil can be gathered in quantity enough," the scientist exclaimed prophetically, "it will revolutionize the world!"

Within the span of a lifetime since, his prophecy has come true.

Oil has indeed revolutionized the world.

It gave light, and then motion, to civilization. It made power easily mobile.

Today the world is on wheels.

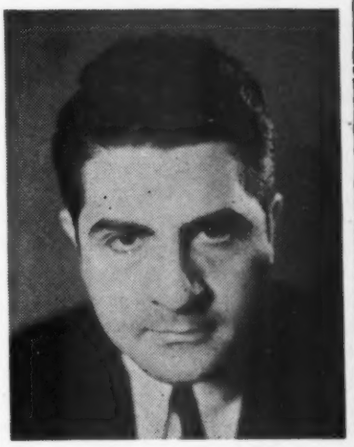
Oil put it there and keeps it moving—oil for the onward turning of destiny.

Today oil meshes the gears of industry, speeds the flashing discs of travel, propels the world's commerce on highway, rail, and water, and feeds the whirring thunder of the new fleets of the air.

The story of finding and supplying this dark life-blood of modern civilization is a story of American achievement. It is an epic of American pioneering, of opening new frontiers of discovery, of solving secrets that nature buried thousands of feet deep, of bringing these benefits across a continent or half the globe, to the world's doorstep.

Essentially its success is a tribute to you—to the man in the office or on the prairie or in the jungle, in the Nation's tall refineries or on the iron arteries of the pipe lines—who put forth your best efforts to provide the world with its oil. The achievements of the petroleum industry are the achievements of you and those who work with you. They are as great as your understanding and vision. Because both have been keen, the industry stands today as the second largest in America. Because both have been broad as well, the industry's size is matched by its record of service both in war and peace.

It was Lord Curzon who, in giving the reason for the victory of the Allied cause, said: "The Allies swam to victory on a sea of oil." That was the work of the American oil industry,



The author of this series of articles, NORTH BIGBEE, has enjoyed a rich experience in oil writing beginning with the fall of 1930 when he was assigned to the newly-created position of oil editor of The Dallas News. This occurred simultaneously with the bringing in of the discovery well in the East Texas field, and for seven years thereafter Mr. Bigbee was editor of the oil page of that daily. During that time The News' oil page became known for its championship of the rights of the oil-producing companies, both independents and majors. The News fought for control of production by the individual states and then, as now, was a considerable influence in Texas, in which state the question has ever been most acute.

He has written for a number of national magazines, including *Fortune* and *Today*, and was at one time connected with Rinehart's oil reports. While he was yet writing his daily column, "Swabbings," for The Dallas News, Mr. Bigbee was picked by *Time* magazine as one of the dozen outstanding business columnists of the country.

Among other oil-writing experiences, Mr. Bigbee formerly handled publicity for the Mid-Continent Oil and Gas Association.

without governmental subsidy or dictation.

In peace time, the wheels of manufacturing and transportation would stop turning tomorrow if oil were taken away. In fact, oil has probably done more for the progress of civilization than any other industry.

It is a natural source of pride to be a member of such an important industry with such a distinguished record of service to the Nation and to the civilized world. And equal to your pride in your industry should be the pride you feel in your own contribution to its efficiency and constant progress. It is an outstanding characteristic of an American that he has pride in his job and in the way that he does it, and the oil worker has plenty of reason to be proud of both.

Arthur H. Little, associate editor of *Printer's Ink*, tells the story of a steel worker in the boom days of that industry, who would slap his big hand on the bar and bellow: "Listen! Do you know what I do? I run the biggest, most God-awful machine ever put together on this continent!"

"And there," says the editor, "spoke pride. Not yet does industry consist of one unbroken assembly line, monotonously rolling into infinity."

Least of all industries does oil incline toward the assembly line system in production, management, or opportunity for its employees. The prime elements that in eighty years have developed this industry from nothing to second largest in the Nation have been the individualism and enterprise of its members. Today, with the danger of regimentation for all American business, both qualities are needed more than ever before to preserve a democracy of opportunity for America's workers.

Today the army of oil numbers more than one million workers who support approximately three million more persons from their earnings.

From an original investment of $1000 in the Drake well, the industry has grown in the eight decades since to a total of nearly $15,000,000,000. For each of its employees this represents an investment of nearly $15,000. In production the investment is three times this. That is, the oil industry has spent for each employee in the producing division an average of $47,500 to provide him with the equipment and materials to do a good job. In the pipe line division each employee represents an investment of $40,600, in refining $38,700, and an average of $6,000 in marketing.

Each year sees $1,500,000,000 earned by this large body of oil employees, ranging from president of a company to the newest member of the labor gang. This billion and a half dollars finds its way into hundreds of channels of American business.

But this is only a small part of the story.

Besides its payroll, petroleum pays to the farmers of America and other landowners a total of $200,000,000 annually in royalties, bonuses, and lease rentals.

The huge sum of $876,000,000 each year is spent with other industries for equipment, supplies, and services providing employment for tens of thousands more workers in hundreds of other lines.

An additional $260,000,000 is paid American railroads, providing jobs for thousands more. In fact, oil is the railroads' best customer.

Almost equalling all these put together and not far short of its wages total is the industry's huge tax bill. Counting Federal, State, and local levies on the oil business and its products, this totals $1,300,000,000 more.

Altogether, oil makes a total cash contribution to the national economy of more than $4,150,000,000 a year.

That's a lot of money.

But the oil industry covers a lot of territory. With producing activities in 22 states, refining in 35, and marketing in all, its far-flung operations assure a widespread distribution of the industry's large economic benefits. In fact, almost every industry profits from oil's four billion dollar payment. Indirectly, almost every individual in the country is affected favorably by it.

That is another reason why each member of this far-flung empire of oil can take pride in the job he is doing, for it is of service to the entire nation. In fact, the oil industry through its outposts of friendliness, the filling station, has given America a new definition of service. No less than a Nobel Prize winner, Dr. Robert A. Millikan of California Institute of Technology, recently pointed out, "The filling station men have improved the manners and courtesy of the American public more than all the colleges in the country."

As for the other branches of the business, the Texas National Youth Administration, in a recent study, concluded that the production and refining divisions provided Texas youths the best opportunities of any business for employment and high wages. Since 1933, working hours in refining, already well below average, have been cut by 5.8 percent. In producing, hours were reduced 5.9 percent. Continuity of employment is remarkably good with employee turnover in refining in 1937 only 60 percent as large as the all-industry average.

Much of the credit for this fine record must go to the high type of ambitious, intelligent employees that the oil business attracts. Part of it is probably due to the friendly relations of both operators and integrated company executives with the associated members of their organizations. In fact, it is still a keen source of pride to most of the independent operators and many of the larger company officers (particularly in production) that they began on a rig as roughnecks.

A number of stories are told when oilmen get together about those who had their start on the rig floor or in the pipe-line ditch. One of the latter, who subsequently had become head of a large Mid-Continent pipe line company, was in the field one day personally walking a company line, a habit he had never outgrown. A rival line paralleled his line for a mile or two, and it happened that a crew was repairing the other line. As the official came by inspecting his own line, they had stopped work for a few minutes to wait for some materials.

The sight of such idleness was too much for the work-hardened old-timer. Leaving his own line, he charged over to the crew, and in language worthy of a pioneer driller, discharged the entire crew of the rival line!

Although such informal labor relations have been supplanted in most companies by system to prevent unwarranted dismissal of any employee, this flavor of rugged independence for which the industry has been known has not yet vanished. In spite of hampering taxes and various investigations and attacks, the oil industry has managed to preserve something of the spirit of free enterprise that built America. It is one of the few industries left that still offer the worker a reward for ambition, for pioneering, for improvements in product or service.

Not long ago a young oilman who came from several generations of bankers was asked why he had deserted the family profession to go into the oil business.

"Nowadays," he explained candidly, "the government runs the banks and almost everything else. Oil is the only business left that I know anything about that offers a young man a real opportunity."

Recently the National Association of Manufacturers took a vote among the employees of a number of leading industries including petroleum. The workers were asked what it was that their employers were not giving them that these employees wanted most.

The answer was—Information.

Recognizing a deficiency that many of their employers had not seen, the workers decided that for the sake of their industry as well as themselves they should be better posted on what

WHERE THE OIL EMPLOYEE'S DOLLAR GOES
GROCERIES, MEATS, AND OTHER FOODS
22 CENTS
RESTAURANTS, SHOWS, DRUG AND TOBACCO STORES
19 CENTS
RENT
15 CENTS
SAVINGS, INSURANCE, AND OTHER INVESTMENTS
15 CENTS
DEPARTMENT STORES
10 CENTS
UPKEEP OF FAMILY AUTOMOBILE
8 CENTS
PUBLIC UTILITIES
7 CENTS
PROFESSIONAL SERVICES
4 CENTS

their business was and what it was doing. They felt that being better informed, they would have a better chance to accomplish something for themselves. Further, they felt that being better informed, they would make better employees for their companies. Lastly, they believed that being better informed about their jobs and their industry, they could more effectively create a proper understanding of that business with the general public upon whom all jobs ultimately depend.

In these times of attack and governmental restrictions on business particularly did they feel that an informed industry has a better chance to weather the storms of legislation and taxation that today threaten the entire American business system.

Especially did those who were contacted want information on taxation. In fact, 53 percent of all who voted, voted for more information on the governmental levies that in recent years have cut so heavily into the money available for wages and wage increases. Petroleum workers showed a particularly keen interest in taxation, as well they may. For their industry is probably the most heavily taxed of all the essential service industries of the United States.

Altogether more than 200 different types of taxes are imposed upon it, with every product and almost every undertaking paying a levy from the time the well is drilled until the last gallon of gasoline is delivered to the consumer's tank.

In the last 18 years, petroleum taxes have averaged about three times the industry's earnings. Actually the average company would be financially much better off if it were allowed to turn over its earnings to the government, in lieu of taxes. Many of the companies pay as much in taxes as in wages, and the tax total reduces or even eliminates the sum available for increased paychecks for employees.

Along this line, an experienced labor leader, the well-known Matthew Woll, recently made an interesting observation. Urging reduction of taxes and the repeal or modification of the capital-gains tax and undivided-profits tax, he admitted such an appeal might sound strange coming from the leaders of millions of workers.

But, as he went on to explain:

"The individual or company employer who has to pay taxes has to get the money somewhere to pay taxes. If the money comes from the consumer, that is, if prices are raised, every worker —every person employed—must pay more for the day-by-day essentials of life and will buy less of them.

"If, however, competition and the threat of reduced production prevent business concerns from passing the taxes on to consumers, then the employees shoulder the burden by a reduction in wages or by loss of jobs. For every dollar spent on pay rolls another 43 cents is spent on taxes. Taxes average about $486 a year per employee. It is therefore not difficult to understand why industry hesitates to employ additional workmen and enlarge upon present payrolls."

Mr. Woll's figures about the average taxes per employee paid by the employer are somewhat low for the oil industry.

For instance, the 1938 annual report of the Standard Oil Company (New Jersey) shows that for every employee, the company paid out $695 in direct taxes alone, or more than $13 per employee per week. What this added to each worker's pay check would mean is easy to see.

The Texas Corporation, which, in 1938, paid $104,357,012.88 in taxes, reported an increase in total levies of 357 percent in 12 years. They represented in 1938 the tremendous average of $3,375.83 per employee.

The Continental Oil Company found that for every permanent worker on its payrolls, various agencies collected taxes aggregating $4,330, or several times his average annual wage!

Cities Service Company reported that its total taxes exceeded the total payroll of the company and all its subsidiaries, adding, "It is a misconception to assume that the tax problem concerns only business or the rich. Taxes paid by business become a part of the cost of its products. As prices go up from such causes, purchases fall off, jobs diminish, payrolls reduce, and the returns to security holders diminish."

The Phillips Petroleum Company found that "total taxes extracted from the company and on its products in 1938 exceeded by more than $7,000,000 the combined amounts paid in wages to employees and dividends to stockholders."

Another company, Socony-Vacuum Oil Company, Inc., which paid or handled $116,475,818 in taxes in 1938, discovered the taxes it paid and collected were more than seven times as great as the dividends it paid to stockholders during 1938. During the last five years, the tax collectors got $86,000,000 more than the employees who were responsible for the success of the company.

The Standard Oil Company (Indiana) not only gave employment to 30,000 workers, but also in creating $97,485,205 in taxes turned over enough to the tax collectors to pay a $2,000 a year salary to each of 48,742 state and federal employees. As the company pointed out, "Thus a business operated by approximately 30,000 workers is called upon to support even more persons performing functions of government."

What this means to the consumer as well as to the oil industry worker is shown by the additional statement: "If there had been no tax at all, consumers might have paid 23 percent less for their products. Such is the importance of taxes in the oil business."

Today every tenth dollar of tax revenue collected is either paid or collected by the petroleum industry. In both cases this is largely at its own expense. In fact, taxes on the oil industry and its products actually exceed the market value of the crude oil, in effect doubling the cost of the product.

In 1938 petroleum's total tax bill was estimated by experts as $1,286,114,473.

Figuring the average salary of a government employee at $2,000 a year (government pays many of its workers more than even oil does), oil and its products paid the full annual salaries of 643,057 local, state, and national employees last year. This is nearly two-thirds as many workers as the entire oil industry required to run it in 1938.

Multiplying the government workers' total by four (the average in a family), oil through its tax payments provided a living for 2,500,000 persons. This is in addition to the 4,000,000 that the oil employees and their own families represent.

Thus the grand total is 6,500,000 persons out of America's 130,000,000. These 6,500,000, or five percent of the Nation, are directly dependent upon oil and its products for their living. That is, one person in each 20 in the United States. One-twentieth of the entire Nation look to oil for their support!

This is a national average. In the principal oil producing states, the figure is higher.

In Texas, for instance, 38 percent of the population of ten of the leading cities depend directly upon oil for their livelihood. Out of the state's population of 6,000,000 nearly 1,000,000 persons look to oil for their living, or one in six.

In addition to these, there are the many others on the public payroll that oil taxes support. In the Lone Star State, oil and its products contributed 64 percent of all state tax collections in 1937, or $70,000,000 out of the $108,000,000 received from all taxable sources. At $2,000 a head per year, that would pay the salaries of 35,000 employees of those taxing agencies, supporting 140,000 persons.

This is one way of considering the

industry's tax bill in everyday terms.

Another that is even closer home is to reflect what could have been done with these huge sums had the petroleum industry been able to keep them for its employees.

If all taxes paid by oil and its products in 1938 could have been added to the wages of its employees, each of the 1,006,052 workers would have received a raise of $1,247.37 for the 12 months. That averages slightly more than $100 per month per employee added to his regular salary.

Think what this would have meant to you.

Think what it does mean to you today, when $100 for each month you work is paid or collected by your industry for the benefit of the various taxing agencies. That is, oil's taxes are the equivalent of $100 a month for each employee in the industry.

In fact the many taxing groups get almost as much during the year as all the oil industry workers in all the production, refining, transportation, and marketing activities get for their work.

Not long ago one of the oil companies made a survey to see how each dollar received by it from a customer was spent.

The study showed that the oil company stockholders got 3.7 cents, the employees 15.6 cents—and the tax collectors 23 cents, or more than both other groups combined. From the rest of the customer's dollar, 38 cents is spent by the company for raw materials and transportation. Other operating expenses consumed 9.5 cents, whereas 7.2 cents went for depreciation on property and 3 cents was tucked away for the economic rainy day.

Of this company's income, the tax collector got half as much again as did the workers who were responsible for the company's successful operation!

The appalling size of the industry's tax bill brings to mind the story about the two stripper-well operators who were having some drinks together. Like many of their kind, both of the small-well owners were having a hard time making ends meet and were sympathizing with each other while drowning their sorrows.

Finally one of them said to the other, "What would you do if you had all the money in the world?"

"You mean all the money?" the other asked. "All the gold and all the silver and all the paper money?"

The first nodded. "Yep. All the money in the world."

The other pondered heavily for a minute.

"Well," he said sadly, "I'd pay it on my taxes—just as far as it would go."

Altogether, oil and its products contribute to the expenses of government in 201 different ways. Of the 39 federal, 121 state, and 41 local levies, the gasoline tax is the most burdensome representing about 75 percent of the tax burden. Although these are paid by the industry's customers (as ultimately most taxes are in any business), the excessive amount of the levies makes the customers less able financially to patronize the oil industry; and the industry is forced to collect these largely at its own expense.

The present overlapping federal, state, and local taxes on gasoline represent an average sales tax of nearly 40 percent. The total sales taxes on gasoline sometimes reach 100 percent. Yet sales taxes upon the products of other industries seldom exceed 3 percent.

In 1938 State gasoline taxes totalled $766,853,000, and the Federal gasoline tax added $200,880,797 more, or nearly one *billion* dollars total. Collections in 1919, first year the tax was imposed, was one *million* dollars. The total has ballooned 1000 times in 20 years.

From 1919 to date the aggregate of gasoline taxes is eight billion dollars. This is a tremendous contribution to good roads. In fact it is equivalent to $2500 for each of the 3,000,000 miles of road in the United States—although only 600,000 miles have been given any improvement at all.

This is due to the fact that 16 cents out of each gasoline tax dollar is diverted to non-highway purposes. The industry suffers doubly from such diversion. In the first place, its customers are taxed exorbitantly. In the second, a sixth of the income is now spent for miscellaneous purposes to the neglect of the roads, the improvement of which constitutes the only possible benefit. To date one dollar out of every eight gasoline tax dollars collected by the oil industry for roads has been spent for other purposes.

Including the billion diverted dollars, the products of the oil industry have been responsible for the contribution of $13,333 for each mile of improved roads in the United States. Or putting this on the basis of each of the 30,000,000 automobiles in the United States, it represents a contribution of $266 per motor vehicle. Many of these could not be sold for this much.

Figuring the seven billion dollars that actually went into road construction, oil's customers have paid out $11,666 per mile of improved highways.

To put it still another way, the amount of roads improved (in large measure by gasoline taxes) is equivalent to a highway belting the world 24 times at the equator. All the 30,000,000 motor vehicles in this country could be put bumper to bumper in a single line on this gargantuan highway and still leave room for approximately 180,000,000 other automobiles —considerably more than have ever been manufactured in the history of the automobile industry.

Each year now, oil and its products pay approximately one billion dollars for the improvement of America's roads. That billion dollars every 12 months is $83,333,333 every month to be spent with the highway construction trades—for road building equipment, cement, rock, gravel, sand, asphalt, and with the hundreds of thousands of workers who build the Nation's traffic circulatory system of roads.

If any one has the right to be particularly proud of the system of improved highways that make possible comfortable travel from one corner of the United States to another, it is the oil industry and the oil industry's employees. For oil products during the last two decades have borne the main burden of the huge sums necessary to build and maintain this widespread system.

The extra heavy tax load that taxing bodies impose upon the oil industry and its customers seems to arise from mistaken notions regarding that industry's prosperity and the wealth of the users of its products.

Actually the average automobile owner (who buys most of oil's products) earns less than $30 per week. His car cost him only $200. Three out of every five motorists in the United States have never bought a new car. Yet each year in gasoline taxes and other automobile levies each one spends an average of $50 with the various tax collectors. Thus, in effect, every four years he buys another car that he never gets; the tax collector takes all that.

The attitude of some of the taxing agencies suggests the story about the old-time wildcatter. Time after time he had drilled a promising structure only to find no oil at all and finally drill into salt water. He had made a last desperate effort and raised money to drill one more test. The driller had just topped the sand that meant either poverty or success for the old man when a couple of seagulls flew over the derrick.

"Isn't that another of Bill Smith's wildcats?" one seagull asked.

"Sure is," answered the other.

"Well, then, what are we waiting for?" the first seagull said, and dived for the derrick.

Such a feeling that the oil industry is fair prey seems general among taxing agencies—local, city, county, state, and national. Not only in the oil-producing

MILK ——— 623,500,000 Lb.

FLOUR AND MEAL ——— 555,000,000 Lb.

POTATOES ——— 524,000,000 Lb.

MEAT ——— 500,000,000 Lb.

BREAD ——— 380,000,000 Lb.

FRESH VEGETABLES ——— 263,000,000 Lb.

FRUIT ——— 180,000,000 Lb.

EGGS ——— 78,125,000 Lb.

BUTTER AND CHEESE 77,000,000 LB.

ANNUAL GROCERY BASKET OF THE PETROLEUM INDUSTRY

TOTAL VALUE	$330,000,000
TOTAL WEIGHT	1,590,000 TONS

VOLUME WOULD:

FILL A FREIGHT TRAIN 305 MILES LONG, KEEP 44,000 RETAIL FOOD STORES AND THEIR 150,000 WORKERS BUSY THE YEAR ROUND.

states but also in most others, taxes paid by or through the petroleum industry constitute the largest single source of revenue. In the average state, more than one-third of all income is derived from taxes on gasoline alone.

Meanwhile, other taxes on producing operations, such as severance, equipment, privilege, and corporation levies, greatly increase the cost of producing the crude oil. The cost of refining it is raised by processing, property, income, license, and other taxes, and transportation levies on motor vehicles, pipe lines, tank cars, tankers, etc., hike both operating and transportation costs. Sales taxes, chain store taxes, bulk plant levies, privilege and license taxes, pump taxes, equipment levies and the like add heavily to the cost of marketing oil's products.

And so they pile up. Many of the levies are admittedly reasonable in themselves, but the great number and their duplication make the total a burden.

The petroleum industry has not objected to bearing its fair and reasonable share of taxation, whether federal, state or local. It has repeatedly expressed its willingness to do so, but it does stand opposed to exorbitant and discriminatory levies, particularly to overlapping taxes, to excessive tax rates, and to use of highway funds for other purposes. With its present levies, oil is perhaps not only contributing its full share but also bearing some taxes that may be considered excessive and even confiscatory.

The taxes paid, however, do give oil and its employees a major interest and stake in government. In fact, since 1921, the petroleum tax bill has increased approximately 1076 percent as against less than 40 percent gain in taxes from all other sources. In the 18-year period, taxes from petroleum sources have aggregated twelve billion dollars. This is larger even than the industry's average investment during this period.

It is also many times the total earnings of the oil industry during a period in which the necessary expansion of its facilities has required the second largest capital outlay of any American industry. During the 18 years, an average of more than 7 percent of all taxes collected by all agencies in the United States have been paid by or through the oil industry.

As for the supposedly large earnings of oil companies and operators, the average annual return on gross investment for the last 17 years has been 2.04 percent. With an average investment during the period of $10,997,308,580, earnings have aggregated $224,415,175. By comparison, some other industries show net returns of 10 to 20 percent or more on their investments. Oil's highest during the 17 years was 4.96 percent in 1925.

Another misconception that may have prompted the tax load on oil is that a few rich investors own all its stock.

Recently one of the American oil companies set out to answer the question of "Who owns the oil industry?" A survey was made, and the answer that it resulted in was the simple one: "People—people like you and me. Perhaps you are one. Certainly one of your neighbors is."

For it was found that more than 2,000,000 individuals own the stock, bonds, and royalties constituting the financial end of the oil business. No securities are more widely or popularly held than those of petroleum. In fact, it was learned that out of all the stockholders in all American industries, one out of every ten owns securities in the petroleum industry.

Furthermore, several hundred thousand of these investors are workers of the company whose stock they hold. Many of them have purchased this with the active coöperation of the company with which they are associated. In numerous cases, the company has administered without cost or even occasionally contributed to the stock purchase plan.

As for the average stockholder, he is likely to be pretty much like you, yourself—making a good livable income and putting some of it away in oil company stocks. Like you, he depends upon his dividends to increase his yearly income, and to provide greater security for his family and for his and his wife's old age.

One of the oil companies recently went out hunting for an average stockholder. He turned out to be a Mr. Harry R. Foster of 2225 East 70th Street, Chicago, Illinois.

Possessing about the average number of shares in the company, Mr. Foster is one of the nearly 100,000 individual stockholders of this single corporation. Although a grandfather, Mr. Foster still works, being busy from 8:30 a. m. until 5:00 p. m. daily as cost accountant for a candy company. On Saturdays and Sundays he likes to take it easy around the house with his pipe and any odd jobs Mrs. Foster has, or perhaps get out for some fishing or shooting, his hobbies. His oil stock is part of his and his wife's protection for the future, and they look to the earnings of the oil company to help them meet their everyday expenses.

Mr. Foster might be you or almost anyone else who owns stock in an oil company, except that he does not work for the company in which he is also a stockholder. And of course, too, his company did not help Mr. Foster acquire his stock.

When you come to think about it, there isn't much difference between an employee and a stockholder. In fact, about the only difference is that the stockholder in one industry is an employee in another. Of course, if you are a member of the petroleum industry, you may have some stock in your own company—an owner's stake as well as a worker's, in the success of your company and the oil industry.

Ownership of company stock by members of its organization is now widespread. In 1933, a total of 1,000,000 out of 10,000,000 individual stockholders in the United States were employees who had acquired stock through a company plan. Today the figure is even higher due to a noticeable increase in employee stock purchases in 1936.

Important as is the major subject of taxation, especially in oil's underwriting of the Nation's great highway system, it is only one example of the industry's contributions to American life and business. These are so many and varied, and the oil industry itself is so vast, that members of it are sometimes prone to assume that outsiders are as familiar with its size and importance as themselves.

In fact, in this particular, the oil industry has been somewhat like the old tanker captain who took the first oil ship around Cape Horn.

Braving the suicidal currents and crashing seas of the Horn (which not long ago almost disabled the United States fleet), the veteran oil sailor was lost to civilization for three months. All efforts of his home office in New York to reach him were fruitless, for his wireless was wrecked beyond repair.

The company had given him up for lost when three months later he sailed slowly into San Francisco Bay, the tanker battered but still afloat. It was the first time a sluggish oil boat had ever made the perilous trip around the Horn, and represented one of the major feats in the history of tanker navigation.

But when he had finally docked his ship, the captain walked leisurely to a telegraph office and wired New York a ten-word report on the trip—collect!

Too often in the past the oil industry has gone on the assumption that if it attended to its own business, gave the public excellent service, and treated its employees well, it could disregard public opinion. But now that all business is under such close and critical scrutiny, a social significance is attributed to even the routine transactions of trade. More than ever before the accolade of public good-will is a large and tangible asset, or its absence a costly liability.

As an oil corporation representative

said recently, "The company which goes human is going to get most of the business." This might be paraphrased to, "The industry that goes human is going to get most of the good-will." Or at least it will pile up a sufficient accumulation of it to protect itself from unjust attack or discriminatory taxation or regulation.

Such good-will is not a mysterious or remote desideratum. It is merely wholesale friendship. The late Will Rogers used to boast, "I never met a man I didn't like." And many who now are not particularly friendly to the oil industry might become so if they were sufficiently acquainted with the many and widespread benefits of oil and its expenditures.

Recently, to find out just how important to other businesses is the money that the oil employee spends, one of the companies made a survey of where each of his wage dollars goes. The largest amount, or 22 cents out of each wage dollar, naturally went for groceries, meats, and other foods.

Next were restaurants, shows, and drug and tobacco stores with 19 cents of each dollar. Rent took 15 cents, and department stores got 10 cents. The rest was divided up between public utilities 7 cents, professional services 4 cents, upkeep of the family automobile 8 cents, and savings, insurance, and other investments 15 cents. The many individual items ranged from bath tubs to baby carriages, from cosmetics to cabbages.

For food alone, petroleum workers spend $330,000,000 a year. Their purchases include 500,000,000 lb. of meat (half a billion lb.), 380,000,000 lb. of bread, 290,000,000 quarts of milk, 77,000,000 lb. of butter and cheese, 624,000,000 eggs, 15,000,000 pecks of fruit, 524,000,000 lb. of potatoes, 555,000,000 lb. of flour and meal, and 263,000,000 lb. of fresh vegetables.

Weighing approximately 1,500,000 tons, this huge grocery order would fill a railroad freight train 305 miles long. That's a great deal of business for a great many farmers, besides the packers, dairymen, produce dealers, mills, and other processers or middlemen whom the farmers supply.

As for the grocerymen required to handle such an order, these purchases of oil workers alone would keep more than 44,000 retail food stores going for an entire year. (The average grocery store does a total business of $20,000 a year.) Nearly 150,000 shopkeepers and their employees would make their living solely from trade with the oil workers.

In addition, drug stores, restaurants, movie theaters, department stores, garages, and the like take an additional $555,000,000 from the oil worker's pay envelope. This makes a total of $885,000,000 of these wages—nearly a billion dollars a year—which flow directly into retail trade.

This does not include the huge sums the petroleum industry itself spends with other industries. According to a survey, this amounts to approximately $876,000,000 a year, ranging from paper clips to tank ships, from rest-room towels to refinery towers. The annual bill for equipment and supplies is broken down as follows:

Drilling equipment	$440,000,000
Producing equipment	72,000,000
Refining equipment upkeep	30,000,000
New refineries and rebuilding	40,000,000
Chemicals for refining	90,000,000
Trucks	30,000,000
Bulk plants	10,000,000
Service stations	59,000,000
Office supplies	25,000,000
Containers and packages	80,000,000
Total	$876,000,000

The total list, which numbered 495 items of which the oil industry bought $25,000 worth or more in a year, admittedly was far from complete.

The tremendous amount spent for drilling equipment reflects the large increases in drilling cost. In fact, there has been an average rise of 50 percent over 1922 prices.

Also greatly swelling this item is the much heavier equipment necessary for drilling to the increasing depths where oilmen these days have to go for oil. The average well today is three and one-third times as deep as that prior to 1920.

An oilman does not need to be told how this has skyrocketed drilling costs. From the few thousand dollars it used to take to drill a well, these have jumped to $65,000 to $80,000 in many areas today. The world's deepest well, which went below 15,000 ft., cost $305,000, or $20.33 a ft. About 20 percent of this went for wages and most of the rest for equipment, supplies, and special oil-field services.

Other wells not so deep have cost even more, due to drilling difficulties. In general, drilling costs go higher the deeper the well goes, but not in the same ratio. For instance, a 15,000-ft. hole costs not three times as much as a 5000-ft. test, but more likely nine times as much. Heavier equipment is a sizeable item of cost in deeper drilling. Sharing in the millions of increased expenditures are tens of thousands of workers in equipment manufacturing plants.

In 1937 alone, the steel industry manufactured for petroleum producers and pipe-line operators more than 1,250,000 gross tons of oil-country tubular goods. To turn this out required an estimated 79,440,399 man-hours of labor, or enough to give 39,300 steel workers work for 52 weeks. At prevailing hourly wage rates, the total payroll created by this one purchase of the oil industry amounted to $60,000,000.

Steel mills are only one of the many divisions of manufacturing that profit from oil's huge yearly expenditures. Each year the industry buys about 6,000,000 drums, 44,000,000 pails, buckets, and other metal containers; $15,000,000 worth of tires and tubes; $2,500,000 worth of lumber; 535,000,000 tin cans; 1,000,000 tons of Fuller's earth; 110,000 tons of caustic soda; $155,000,000 worth of paints and chemicals; $32,600,000 of electric power for service stations, and $2,300,000 worth of pipe fittings and connections.

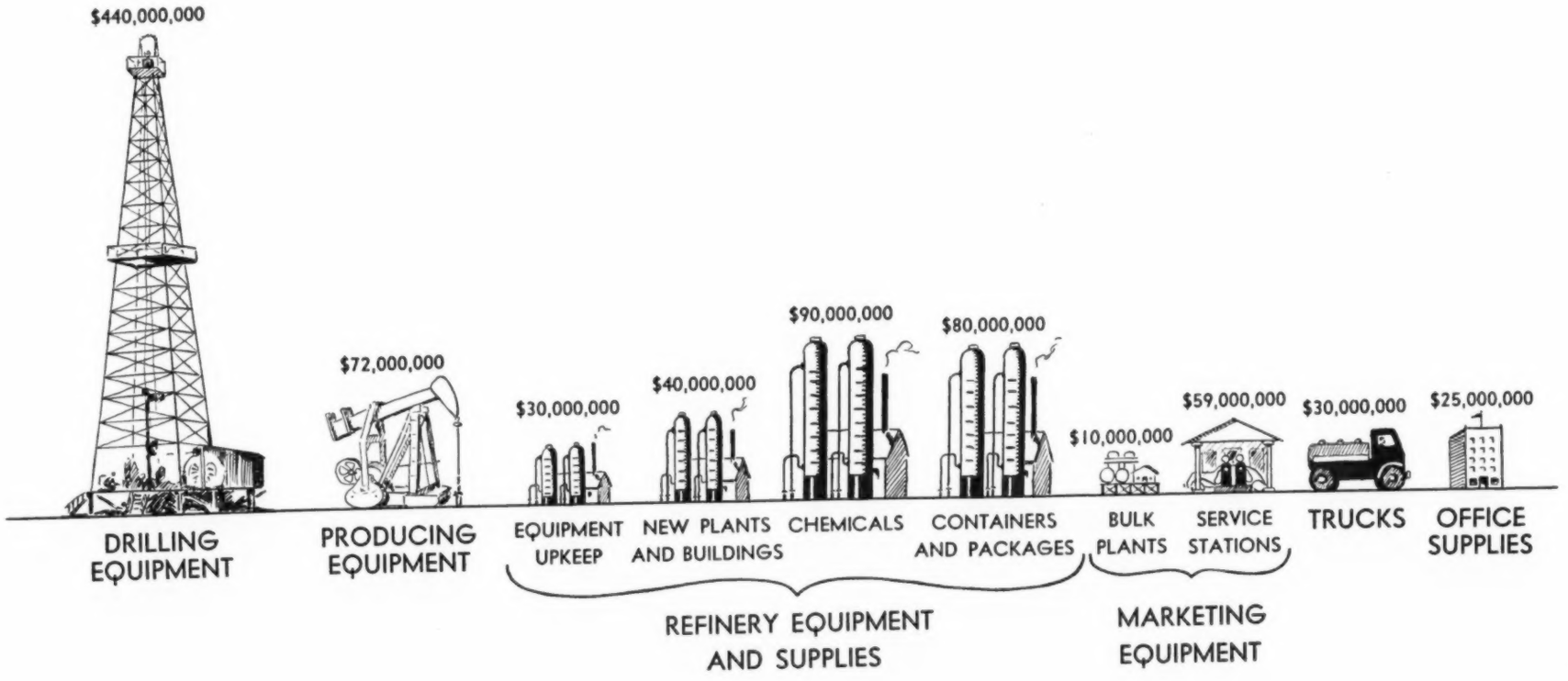
Among its larger purchases, oil's more than 400 tankships and hundreds of river and harbor barges have made the industry a major customer of American shipyards. Most of the 150,000 railroad tankcars used to haul petroleum and its products are owned by the industry, which each year spends about $6,000,000 for new cars and repairing old ones.

Incidentally, oil is the railroads' largest shipper of manufactured products. In 1937 it supplied the carriers with 63,027,707 tons of carload freight, or 6.3 percent of all carload tonnage carried. Costing the petroleum industry $261,593,159, this represented 8 percent of all railroad carload revenue.

Translated into terms of labor, it kept 89,000 railroad men at work all year. Tens of thousands more were required to handle the large shipments of pipe, derricks, refining equipment, etc., that the oil industry bought.

To determine exactly the amount of business and employment created by the expenditures of the oil industry and its employees would take an army of experts many months. The random examples mentioned illustrate the wide range of distribution these dollars attain.

In fact, the economic contribution of oil's $2,500,000,000 worth of purchases each year is almost as important to American economic life as the more than 300 products that the petroleum industry supplies for the many varied demands of the present mechanized civilization. Both are evidence of the fact that within a relatively few years the petroleum industry has become vital to every modern business and one of the most important elements in the progress of a world of turning wheels.



ANNUAL BILL FOR EQUIPMENT AND SUPPLIES IN THE PETROLEUM INDUSTRY OF THE UNITED STATES

$876,000,000

What oil means to the farmer is seen in the $200,000,000 that the industry pays each year to landowners in bonuses, rentals, and royalties.

In the state of Texas alone, oil pays these landholders $105,000,000 a year. Computed in terms of crop value, these payments (mostly to Texas farmers) constitute an extra cash crop equivalent to 23 cents for each dollar the farmer receives from his agricultural products. That is almost a one-fourth increase in income due to oil.

In this one state, 45,000,000 acres of land are now under lease for oil and gas, 240 counties out of 254 being under development.

Oil is also a principal contributor to the education of the farmer's children, particularly in the producing areas. For instance, in 86 oil counties of Texas, the oil industry pays 41 percent of all tax revenue. In 15 of the larger school districts in oil-producing sections, 88 percent of all school tax revenue is paid by oil! Many of these outlying school districts have school buildings that surpass those in the largest cities, and curricula that include even college courses.

Fifty cents of each dollar spent by the oil industry in Texas, principal producing state, goes to the farmer and the oil worker. Of the $375,000,000 total spent with these two groups, oil employees receive $270,000,000 yearly. Thirteen percent of the total, or $100,000,000, goes for state, local, and federal taxes. Twice that amount, or $200,000,000, is spent for materials and supplies, and $80,000,000 goes for overhead and all other expenditures, making a total of $755,000,000 spent each year by the oil industry within this one state.

At the same time, the Texas oil industry produced only $750,000,000 worth of products in 1938, leaving a deficit of $5,000,000 for the year. Despite the rich oil reserves in Texas, which holds nearly 55 percent of all the known petroleum in the United States, the industry did not operate at a profit under its present heavy tax and equipment-cost load.

In fact, far more money has been put into the ground by the oil industry than it has ever taken out. This is due largely to the fact that operators and companies are constantly reinvesting their profits from operations in expanding oil's facilities. To the end of 1937, the oil industry had invested in Texas alone the huge sum of $6,700,000,000. Total value of its products to that time was $6,085,000,000, leaving a deficit of $615,000,000. Divided by 175,000, the number of Texas workers, this is equivalent to a debt of $3514 for each employee on the Texas oil payroll.

One reason for the continuing deficit of the industry is the heavy cost of finding new petroleum reserves for the Nation. But it is one of the numerous expensive services that the industry finances for the benefit of the consumer.

Despite advances in geology, geophysics, and the many other scientific methods of locating structures having oil-bearing possibilities, the final proof is drilling a well. After all, it is the wildcat test that opens a new field; and with most of the shallow, more easily found structures already drilled, wildcatting is increasingly expensive.

Despite the high cost of prospecting, however, the oil industry has been indefatigable in its search for new fields. The graveyard of dry holes extending from New York to California and from Florida to Washington State is a tribute to the undying optimism of the oilman.

To January 1, 1939, the industry had drilled the amazing total of 213,689 dry holes. Figuring the average cost as $20,000 (many have cost hundreds of thousands of dollars) the expenditure has been $4,000,000,000, all sunk forever in Mother Earth's barren breast.

In Texas alone, the oil industry has sunk one billion dollars in dry holes. Within the last 49 years, the oil and gas industry has drilled 176,000 wells in Texas, of which 50,000 proved to be dry holes, or nearly one-third of all wells drilled including those in proven territory. Of the 126,000 producers completed, however, only 88,000 are still producing oil and gas. Thus, in addition to the 50,000 dry holes, the industry lost 38,000 others through abandonment because of physical or economic difficulties. In this state the industry has drilled twice as many wells as are now producing, a percentage of loss emphasizing the costly hazards of the oil industry.

Yet dry holes have to be drilled if the oil is found.

A recent study shows that on an average for the entire life of the American petroleum industry it has taken the drilling of one dry hole for each 179,000 bbl. of new reserves discovered. The results of this wildcatting have ranged from 91,000 bbl. (in 1906-1910) to 309,000 bbl. (in 1936-1938) average discovery per dry hole drilled. The moral is that the only way to find a billion barrels of oil is to drill 4000 dry holes! At $20,000 a dry hole, that's $80,000,000 to find one new big field.

As one can see, the chances for failure are excellent.

In fact, a study made in 1937 by Dr. F. H. Lahee, former president of the American Association of Petroleum Geologists, showed that even with all the resources of modern science, only one wildcat in eight finds any oil. (The ratio of dry holes to total wells drilled, which was 22 percent in 1938, of course does not reflect the chances taken in exploration, as most completions are made in proven territory.)

Science still scored considerably higher than farmer geology. Of every 100 wildcats drilled in 1937, 82 were located on the basis of geological or geophysical work, whereas 18 were staked purely on hunch. Of the two groups, the scientifically-located tests yielded one strike in 6½ tries, whereas the doodlebug or rabbit's foot school of prospecting scored only one strike in 17.

Costly as it is, wildcatting cannot be neglected if it is to maintain the reserves the Nation must have. Even in times of ten cents a barrel for crude, the petroleum industry has to continue prospecting if it is to have new sources available when present ones are exhausted.

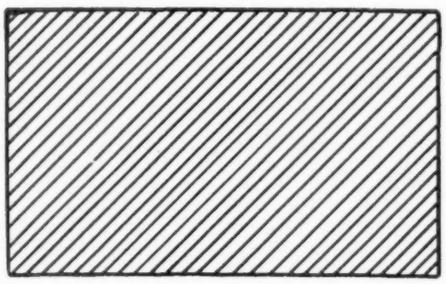
The latest definite estimate of the proven crude oil reserves in the United States, made January 1, 1939, by American Petroleum Institute engineers, was 17,348,146,000 bbl. At the 1938 rate of production, this would last about 14 1/3 years. Another made in July, 1939, by T. G. Delbridge, president of the American Society for Testing Materials, was merely, "Sufficient crude to supply the Nation's needs for probably 150 years."

This latter prophecy unconsciously discloses a strong faith in the ability of the American oil industry to find new reserves. Delbridge's long-time estimate is more than ten times the amount already in sight. Reflecting a general faith among those the oil business serves, it is a vote of confidence that the petroleum industry, which has always found the oil the Nation needed, will continue to do so.

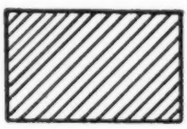
Clarifying a popular misconception concerning these estimates of recoverable reserves is a section of Joseph E. Pogue's recent study, "Economics of the Petroleum Industry."

"Estimates of the known reserve of recoverable oil have been made repeatedly over the past thirty years by various experts and committees," Pogue points out. "Invariably the reports of these studies have aroused concern in respect to the apparent shortness of the country's oil future as expressed in the number of years over which the indicated reserve would stretch at the current rate of production.

"Such inferences have overlooked the true nature of the proven reserve, which is merely that of a working stock in advance of production. The proven reserve is quite a different matter from the volume of oil yet to be produced, for the former represents only the apparent volume of blocked



$155,000,000 FOR PAINT AND CHEMICALS



$32,600,000 FOR ELECTRIC POWER IN SERVICE STATIONS

$15,000,000 FOR TIRES AND TUBES

$2,500,000 FOR LUMBER

$2,300,000 FOR PIPE FITTINGS

535,000,000 TIN CANS

44,000,000 PAILS, BUCKETS, AND OTHER METAL CONTAINERS

8,000,000 STEEL DRUMS

110,000 TONS OF CAUSTIC SODA

Volume of annual purchases of some major items that comprise about 30 percent of the U. S. petroleum industry's annual bill of $876,000,000 for equipment and supplies.

out oil, whereas the latter includes oil yet to be discovered as well as additional oil to be recovered from known deposits by improved methods.

"In fact, one of the prime causes of the recent increases in the indicated reserve is the revision brought about by the increased efficiencies of improved technique and delayed production. The size of the proven reserve gives no clue to, and logically cannot be expected to reveal, the imminence or remoteness of scarcity. The only basis for anticipating an ultimate shortage of domestic petroleum is a line of reasoning based upon the principle of elimination—that each pool found means one less to be discovered in the future—but the sheer magnitude of the proven reserve sheds little light upon the questions:

"How much oil is yet to be found? And to what extent will recoveries be increased by improved technique?

"The factual responses to these queries have upset all inferences in the past. The basic consideration regarding the future supply of petroleum is not the size of the *proven reserve* but the effective magnitude of the *future reserve.*"

The importance of the oil industry's constant technical progress in increasing the effective magnitude of the Nation's petroleum resources can hardly be over-estimated.

By former methods of straight distillation, crude oil yielded only 20 percent gasoline, leaving 80 percent of the original crude in heavier products. Now, by working over the less-valuable heavier products, cracking has more than doubled the amount of gasoline yielded by a barrel of crude.

As gasoline is oil's principal commercial product, this has in effect doubled the effective size of the Nation's oil reserves so far as oil's consumers are concerned. To produce by earlier methods the total of gasoline consumed since 1921 would have required the production of 10,000,000,000 additional barrels of crude, or about double the amount actually needed.

Another important advance is the manufacture of natural gasoline from natural gas. The gas that lifts the oil to the surface thus serves a double purpose, resulting in the saving of many barrels of crude a year that otherwise would be needed to meet the Nation's gasoline requirements. The total production of natural gasoline plants is now around 2,000,000,000 gal. a year. Counting 20 gal. recovery of gasoline per bbl. of crude oil, this phase of the industry's operations alone saves 100,000,000 bbl. of crude a year.

Many improvements have been made by the industry in the quality of today's motor fuels by blending the natural gasoline with gasoline refined from crude. A still further improvement by the industry in refining, the utilization of refinery gases by a polymerization process, has resulted in an extremely high-grade, high-octane gasoline helping meet aviation's demands for still better fuels. It also has resulted in increasing the amount of gasoline available, particularly in war-time, without necessitating the production of more crude oil.

Still further advances in refining are expected from new catalytic processes. Promising almost complete flexibility of control, they allow the refiner to produce any desired percentage of any of the more important products. More general adoption of these methods should greatly simplify the storage problem, long hanging over the industry, created by seasonal demands for certain products while other products pile up.

Also expected from this process is the satisfactory commercial production of motor fuel from even the heaviest residual fuel oils, use of almost any type of crude oil to make the highest-type refined products (impossible heretofore because of the characteristics of certain crudes) and production without special treating of high-octane automobile and aviation gasolines. All these processes have been developed after long and expensive research.

Although the demand now for high-test aviation fuels is comparatively small in comparison with that for automobile gasoline, oil has built ahead in anticipation of any national emergency. In no other country of the world can so much aviation-type fuel be made as quickly and cheaply as in the United States. Such developments have been almost entirely on the initiative of the petroleum industry and at its own expense.

But the oil business has not been content to produce these higher-type fuels merely for a premium trade.

The regular grade gasoline that the motorist buys today is probably twice as good as it was two decades ago, and costs about half as much (save for taxes). Constant developments in automobile motor design, with use of higher compression ratios, have been met with ever-higher anti-knock rating for regular gasolines. Often the oil industry has been ahead of the automotive engineer and generally has marketed a fuel superior to that which the engines have required. Even today standard motors do not take full advantage of the power in fuels available the Nation over at the roadside filling station.

Although octane ratings have been in use only seven years, even in this time they have shown a marked increase. Regular gasoline climbed from an average octane rating of 61 in 1932 to 70.5 in 1938, and moved even higher in 1939. From 74 in 1932, premium grade has risen to 78.7 in 1938, and in 1939 some of the premium automobile fuels were sufficiently high to be used without change for airplanes.

A remarkable uniformity is shown all over the country in the quality of the gasoline marketed. Quarterly laboratory tests by the U. S. Bureau of Mines of gasoline purchased in the open market in all sections of the country have shown almost identical octane-ratings.

The tests also demonstrate that the gasoline sold today is well in advance of requirements established by government specifications, due to voluntary improvements by the oil industry at its own expense. Also, few if any state specifications demand fuel quality as high as is available at every corner service station.

One of the industry's major steps in improving fuels has been in increasing their volatility. In fact, several years ago the volatility reached a point higher than is required even now by automobile motors; and the refining engineers are still well ahead of the automobile technicians. Seasonal variations in fuel volatility to meet weather changes in each section of the country are another of the betterments made by the industry for the benefit of the consumer.

Not only gasoline but also lubricants have undergone improvement. To meet increasingly rigid specifications of industry, scores of special oils have been developed for unusual industrial needs; cutting oil, emulsifying oil, penetrating oil, rust-proofing oil, candy-maker's oil, egg-packer's oil, brick and pottery oil, and scores more. One of the latest advances in the lubricating field has been the introduction of solvent refining, which, besides making possible use of a great number of crudes previously valueless for lubricants, actually has produced lubricants improved in some ways.

Heating oils, too, come in for their share of attention, many refiners maintaining special laboratories where these oils are tested under operating conditions in all types of oil burners and heating plants. Each of the more than 300 separate products of oil is subject to the same search for improvement by the oil industry. Indeed, many of the betterments in petroleum products are due to the American refiner. The petroleum industry's expenditures for refinery research are enormous, yet they constitute only one phase of an industry-wide search to develop better methods, better products, and better service—usually at lower prices.

Not merely the refining but also the

producing division of the oil business has made advances that greatly increase the effective magnitude of America's oil resources.

The petroleum engineer's rapidly growing knowledge of the characteristics of producing sands is making it possible for producers to take from the ground a much larger percentage of the oil present. By chemical treatment of sands, full utilization of underground pressures, repressuring to use gas again, water-flooding of old sands, and other methods, millions of barrels of oil that previously would have been lost forever can now be recovered.

Through orderly production, new fields can be flowed at rates that will insure the longest life and most effective use of pressures. Old fields, believed near exhaustion, have had scientific gland treatments through flooding, acidization, and new methods of lifting, which will make them productive for years to come. Indeed it has been possible to re-open old wells shut-in for years because they had stopped producing, and to make good producers out of them. The importanee of the work of the petroleum engineer in adding to America's recoverable petroleum reserves cannot be overemphasized.

In transportation, pipe lines have opened to producers the distant markets at tariffs much lower than freight rates. Continuing study of pipe-line construction and maintenance is lowering operating costs and rates, and improving the service. Today the network of pipe lines built by the oil and gas industries is a vast circulatory system covering a large part of the Nation. Totaling 112,000 miles in length, the oil industry's arteries transport a billion barrels of oil a year. A fourth of the Nation is served by the 172,000 miles of natural gas lines, carrying fuel found by oilmen in their search for petroleum.

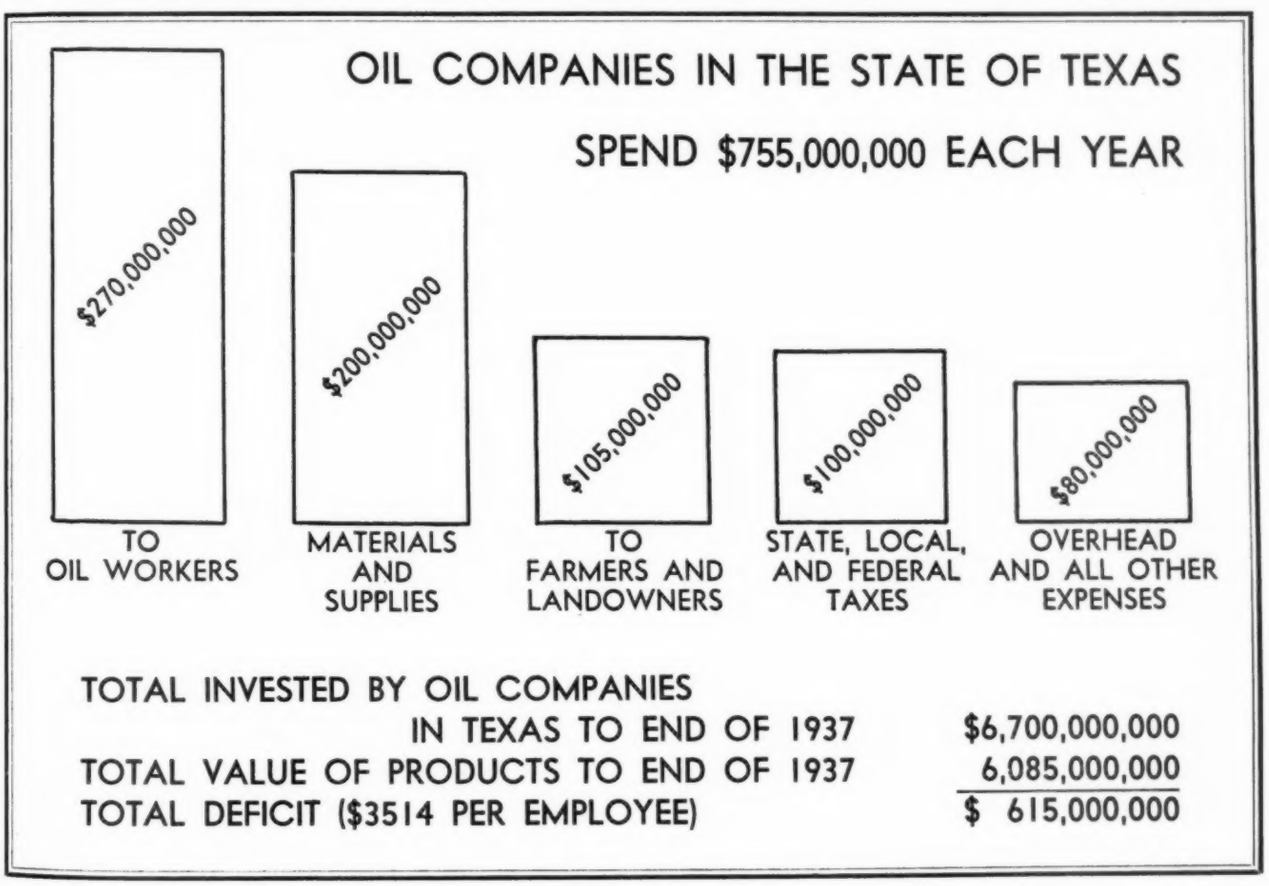
Improved tanker design has cut costs of ocean transportation, particularly from the crude-producing areas to the millions of consumers in the large Atlantic seaboard market. Extensive establishment of local bulk plants and of a nationwide tank-wagon delivery system has made possible a never-failing supply of products to 406,000 retail outlets scattered from the Florida Keys to the Maine woods and from the mouth of the Rio Grande to British Columbia. No other industry, with the possible exception of the newspaper business, has developed such efficient, rapid, and widespread distribution of its products.

In fact, so far-flung is oil's long frontier of service that it has become a subject for fun-poking. A comic drawing in a recent issue of a national magazine showed a frost-bitten and weary explorer finally reaching the Pole, only to discover a service station awaiting him with all oil's customary products and services—including the igloo version of a registered rest-room.

Possibly no other business, save the distribution of food, touches the average American as often and as intimately as oil. Through the 200,000 service stations and 206,000 other retail outlets, the petroleum industry offers the average family a variety of services with its oil and gasoline that surpasses anything ever attempted by any other industry. It is estimated that the gasoline retailers of the country contact from 25,000,000 to 30,000,000 of the population of the United States each week, and that the average American family each year consumes 1700 gal. of petroleum products.

This large volume of purchases is due in part to the oil industry's better products at lower cost. As a result of the industry's improvements in refining methods a dollar today will purchase 50 percent more gasoline than it did in 1923. Yet a dollar will buy only 3 percent more sundries, 15 percent more housing, 18 percent more fuel and light, or 24 percent more food, than in 1923.

Nowhere else in the world can a motorist purchase motor fuel as cheaply as in the United States. For instance, it is 55 cents a gallon in Germany and 72 cents in Italy. Significantly, the United States with only 6 percent of the world's population, has


OIL COMPANIES IN THE STATE OF TEXAS
SPEND $755,000,000 EACH YEAR
$270,000,000
TO OIL WORKERS
$200,000,000
MATERIALS AND SUPPLIES
$105,000,000
TO FARMERS AND LANDOWNERS
$100,000,000
STATE, LOCAL, AND FEDERAL TAXES
$80,000,000
OVERHEAD AND ALL OTHER EXPENSES
TOTAL INVESTED BY OIL COMPANIES IN TEXAS TO END OF 1937 $6,700,000,000
TOTAL VALUE OF PRODUCTS TO END OF 1937 6,085,000,000
TOTAL DEFICIT ($3514 PER EMPLOYEE) $ 615,000,000

70 percent of all its motor vehicles—or one for every four persons against one for 149 in the rest of the world. Low-priced oil products make possible America's wide automobile ownership, one of the outstanding manifestations of the Nation's higher standards of living.

Yet not infrequently some uninformed outsider blames the oil industry for the "high price of gasoline." The fact is, of course, that continued increases in gasoline taxes have almost nullified gasoline price economies passed on to the consumer by the oil industry.

Not infrequently the industry is the victim of misconceptions among even the most sincere, which brings to mind a true story particularly for men in the producing end of the business.

A deal was on for a large producing property, the company buying it having to borrow most of the money from an eastern bank. Unwilling to accept the company engineer's report, the bank sent down its own office staff of engineers who carefully checked everything. After so long a time they submitted their own report, accepting the field engineer's findings, and approving the purchase.

In their conclusion, however, they added: "Everything seems to be in order except for one thing, which must be stopped. There are a number of flares burning on the property. These constitute a distinct fire hazard. Please see that they are put out."

How far wrong are the charges about high-priced gasoline is seen in the price of the average family's requirements for the year. In 1920 the cost of 700 gal. (roundly the average yearly consumption per motor vehicle now) was $208.18. In 1939 the same amount cost $98.49, a saving of $109.69.

Unfortunately increased taxes make up the difference, however, so the motorist doesn't get to keep much of the saving.

For instance, in 1920, the first year after a gasoline tax was put into effect, the average service-station price of gasoline exclusive of tax was 29.74 cents a gal. The average gasoline tax was merely nine-hundredths of one cent.

In 1938, the average service-station price of gasoline exclusive of tax was 14.07 cents a gal., or less than half as much. Yet the average gasoline tax by this time had swelled to 5.44 cents per gal., giving a retail price including tax of 19.51 cents. The tax, which in 1920 represented three-tenths of one percent of the cost of gasoline, had by 1938 jumped to 38.7 percent of that cost.

The result was that whereas the average motorist's gasoline cost him half as much a gal. (without tax) in 1938 as in 1920, his total bill was about the same. In 1920 he used approximately 441 gal. a year and paid $131.55 for it.

In 1938, he used 661 gal. (or 220 gal. more), which he bought for $128.96. The extra 220 gal. were a premium from the oil industry through improved methods of refining and lowered cost of operation. But his tax bill, which averaged 40 cents a year in 1920, had grown to $35.96 in 1938, which made his total expenditure virtually the same.

Of this expenditure, each motor fuel dollar that the motorist spent in 1920 bought 3 1/3 gal. of gasoline. In 1938 his dollar bought 7 gal. of gasoline, but his tax was an additional 38 cents. Because of taxes, every third gasoline sale today is a blank for the retailer. Figures show that the average service station does a total annual business of $9060 of which $4080 is taxes, or 41 percent of the total income.

The service station has become as much a part of the fabric of American life as the personal mobility that it makes possible has become an accepted and unremarked habit of American thought. If America has made any major contributions to the stream of civilization, they are the assembly line for mass production and the service station for individual distribution. Probably never before in the history of trade has the sale of goods been attended by so many or such elaborate premiums of courtesy.

As for the place of oil in our civilization, even the suggestion of its possible elimination shows how integral it is with the present system of transportation and manufacture.

Source of more than 300 important products, petroleum is a vital element in national defense, a fundamental to industry and commerce in this mechanized age, and a source of wholesale extension of business and social activity to millions of individuals. It supplies the seven-league boots of transportation that have pushed back almost incredibly the boundaries of the individual world each of us lives in. Next to air, water, and soil, petroleum is probably the most widely-used natural product. Yet outside the members of the oil industry, its benefits and services are either not known or are taken for granted.

Only once has oil come to the general attention of the Nation. That was during the World War when the demands of the modern armies and navies put heavy demands upon the American oil industry. Mobilizing its resources the industry pushed the drilling of new wells at an unprecedented rate, increased the number of refineries nearly 170 percent, built scores of ocean tankers and millions of barrels of additional storage.

The United States alone of all nations has developed its petroleum resources through private enterprise. Since 1917, the Nation's oil resources have been trebled, refining capacity has been quadrupled, and the gasoline recovered from a barrel of crude oil more than doubled in both amount and quality.

Should the United States be led into another conflict, it will enter with twice the number of producing wells and four times the annual production of crude of 1917. Besides these, it will have the best lubricants and gasoline, both automotive and aviation, that have been made, and in sufficient quantities.

Oil meets the less sensational demands of peace equally well. Today the American economy depends upon the rapid and efficient production of goods and their rapid delivery at the point where they can be sold. Petroleum supplies the fuels and lubricants for both these essential services.

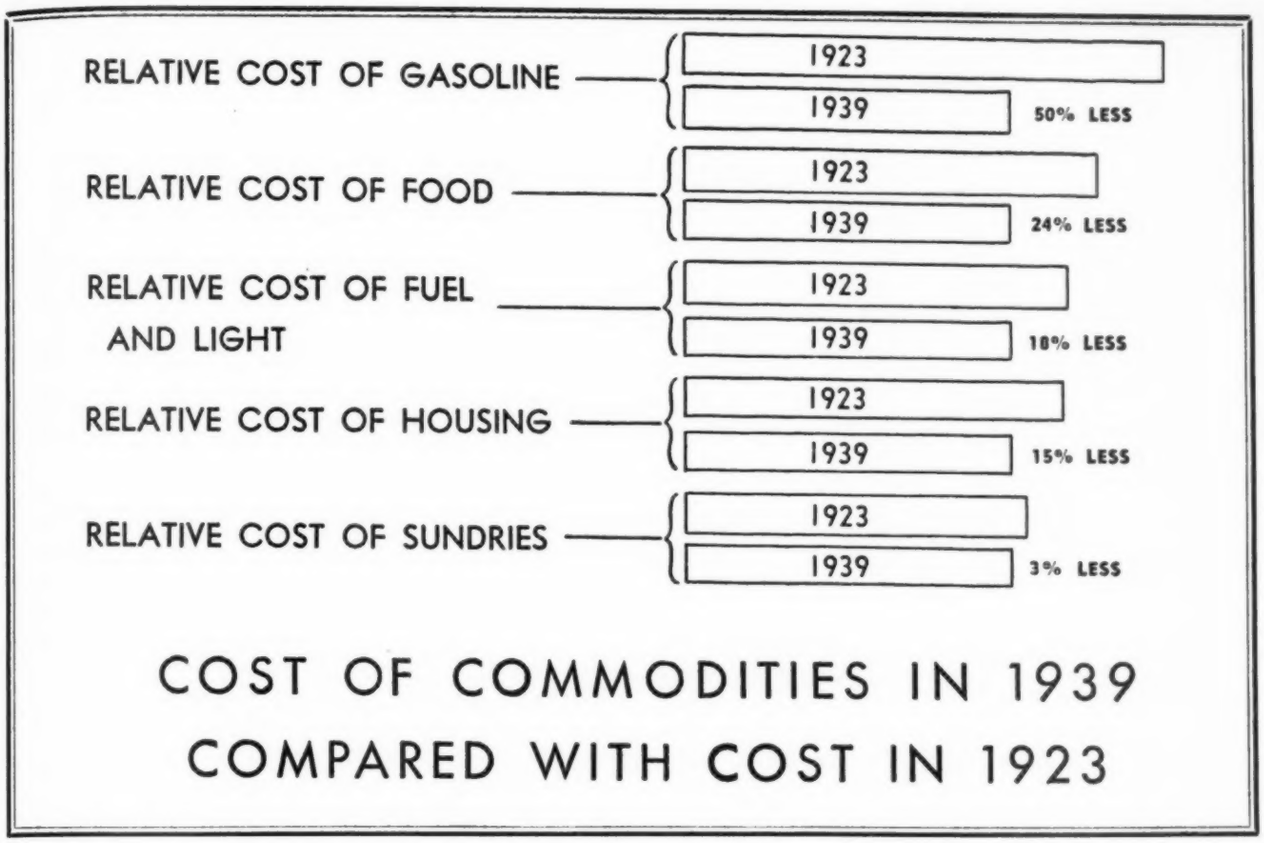
It has made possible the development of automotive transportation, one of the greatest economic phenomena in history. Most of the social and economic changes taking place in America in the last 40 years are the result of the growth and progress of such transportation.

Petroleum supplies the lubricants and in some cases, the fuels, to turn the wheels of industry. The growth of manufacturing in this country parallels the development of the petroleum industry. From 1879 to 1929, the value of the output of the factories of the United States jumped fourteen times, from $5,000,000,000 to $70,000,000,000. It is hardly possible that this could have happened without oil and its products. Industry (as well as the home) is also turning increasingly to oil for fuel and heating. Shipping runs on fuel oil the world over.

An even newer use for petroleum and its products now looms as important. It is for constituents or bases for manufactured products of other industries. It may equal coal tar in variety and quality of possible derivatives. Technologists are predicting that the petroleum industry, within a reasonably short time, may be a huge chemical industry supplying petroleum solvents, detergents, explosives, paper, textiles, and perhaps even food.

Not merely in the creation of new products to meet new demands but also in the establishment of new techniques for mineral production, processing, and distribution, has the oil industry set high standards of achievement.

As Ida M. Tarbell, long a brilliant analyst of the oil industry, says in her



introduction to Paul H. Giddens' recent history of early Pennsylvania oil, *The Birth of the Oil Industry:*

"An industry does not develop alone. It depends on others and, if it grows, carries them along. The stimulus the oil business gave the lumber business cannot be reckoned, nor can that it gave to iron in many forms. Not only were old and established trades and occupations energized, extended, but new lines of activity were opened by inventors, answering the call for better tools, containers, transportation equipment, stills and refining processes, more practical lamps and burners.

"To achieve these results, the industry had called upon all of the scientific, mechanical and commercial forces of that day. It had used men of imagination who dared to risk all they had on the adventure of seeking oil. It had used capital wherever it could be found. It had used the promoter and the speculator. It had called on the chemist to evaluate the products and had set him up a laboratory to enlarge and improve them. It had called on the engineer to apply all known mechanical devices and to find ways to solve the almost daily problems that arose in the producing and handling of oil. It had adapted the markets of the world, exporters, importers, salesmanship, to distributing its products.

"The way that all these varied activities fell into line, promptly and automatically organizing themselves, is one of the most illuminating exhibits the history of our industry affords, of how things came about under a self-directed democratic, individualistic system: the degree to which men who act on the 'instant need of things' naturally supplement one another—pull together."

The history of the oil industry has been a repetition of the success of that early and democratic form of operation. Developed entirely without governmental subsidy and almost entirely by private enterprise, the oil business is a notable example of the benefits of private operation.

No government order has required the industry to find new fields, develop more efficient methods of production, and cheaper types of transportation, or invent new and more productive ways of refining—and pass the benefits of all these along at lower costs. Yet the oil industry has done this, and keeps on doing it. The supply of its products has been continuously available at reasonable prices, and in the far places of travel as well as in the next block to home. Never have the American people been inconvenienced or even threatened by a prolonged shortage of oil and its products.

In considering what the oil industry has done under the American system, it is difficult to conceive how its operations could have been extended to such lengths of efficiency, service, and availability under governmental direction. A comparison with a government-operated oil industry as in Russia shows how efficient is the American system of private enterprise.

The vast amount of ground that must be covered in even this informal highlighting of the many and varied services of the petroleum industry leaves little room in this preliminary article of *The Petroleum Engineer's* series of four on "This Industry of Ours", for perhaps the most important phase of all oil's activities. This is the human.

For notable as are oil's contributions to national economy and national defense and to opening new horizons for transportation and industry, its contributions to better working conditions, higher wages, and greater security must still loom as more important to the millions who have enjoyed their benefits.

Real earnings in the petroleum industry, as the U. S. Department of Labor reports, even exceed those of the boom year of 1929. Hours worked per week have been reduced an average of 30 percent, but hourly earnings, for a time 17 to 45 percent higher, have subsequently been increased to 48 to 55 percent. More than 250,000 additional workers have been given jobs by the oil industry since the depths of the depression. Producing, refining, and natural gasoline workers have wage rates and weekly earnings far above the all-industry average, and among the highest of all.

As for other benefits, the oil industry has long been a leader in advocating and practicing better relations with its employees and offering them better opportunities.

The government is demanding today that industries provide adequate rates of pay, old-age pensions, safe working conditions, reasonable security of employment, and other things for the benefits of their workers. Yet these and many more, including employee representation, vocational education programs, safety training, housing facilities, sick benefits, and hospitalization, have been in effect in one form or another among branches of the petroleum industry for years. Some of the oil company plans go further and provide larger benefits than any of the governmental plans contemplate. Actually the government's standards in these benefits are below what sections of the industry have long had in force for members of their organizations.

Variety of opportunities is another benefit that oil offers. Because of the industry's extensive and diversified undertakings, it utilizes the talents of almost every profession and the skill of almost every trade. For instance, even the single and relatively small geological department calls on the expert services of geologists, geophysicists, paleontologists, seismologists, lithologists, electrophysicists, cartographers, chemists, stratigraphers, and others.

Listing the types of ability required in the many producing activities, in refining, in natural gasoline manufacture, and in pipe-line construction and maintenance is like cataloging the professions and trades of America. It would be difficult to find any type of skill for which the oil industry does not need, use, and pay well.

Few industries, also, offer such opportunities for the worker to establish his own business enterprise. A large proportion of the many thousands of oil companies, corporations, and partnerships now operating in the oil industry have grown from an individual (or group of individuals) who went into the oil business for himself off the rig floor, or out of a refinery, or from under the canopy of somebody else's service station.

Particularly in the marketing division in the last few years have emerged tens of thousands of independent oil merchants. As a leading marketing official commented the other day, "The American oil industry has put more men in business for themselves in the last ten years than all other business combined."

In the field of friendly relations between its management and its men, the petroleum industry has also been successful. Figures from the U. S. Bureau of Labor Statistics for 1938 show that all mineral industries rank only behind agriculture and fishing, both of which are often individual enterprises, in the small number of strikes, few number of men involved and short number of hours lost. And of the mineral industries, oil is almost untouched by labor difficulties, a decided contrast with coal, which ran up the mineral division's total considerably with its 1938 strikes.

The reason for the coöperative relations of those associated in the common enterprise of finding and supplying oil and its products is the fact that the oil industry is essentially a democracy.

The roustabout of today may be the independent producer of tomorrow. The company official of today probably was the roughneck or the stillman or the pipe-line walker of a few years ago. Possibly as in no other industry do intimate and friendly relations exist between management and employees. One reason is that the official may have faced the worker's problem himself so few years ago as not to have forgotten what he wanted done then. Another is the frankness with which oilmen are accustomed to dealing with each other.

Of course, no industry's industrial relations are perfect. The oil industry has made its mistakes in these just as it has made them in its public relations.

But as President Axtell J. Byles of the American Petroleum Institute, spokesman for a large sector of the industry, recently declared, "Reduced to its simplest common denominator, good public relations for industry mean chiefly the observance of proper industrial etiquette. If an industry lives up to the requirements of industrial etiquette, it will enjoy satisfactory relations with the public because it can get along with itself. It will merit the confidence of the public because it has earned the confidence of its own people. An industry which merits the respect both of its own people and the public will find that in winning that happy position, it is so conducting its operations that there can be no other result."

A major share of the responsibility for making a success of industrial relations is the employee's.

As C. R. Dooley of the Socony-Vacuum Oil Company, Inc., an industrial relations authority, recently pointed out: "That the workers in this country should have some clear conception of the tax problem is obviously helpful to industry. And this is only one illustration of how important it is for a company to have the confidence and understanding of its employees.

"But the understanding should extend beyond the financial and economic problems which a corporation has to face; it should include an appreciation of labor problems themselves * * * *.

"The problem in industrial relations is primarily one of understanding on both sides. Understanding requires information—and certainly it is the *joint* problem of both management and employees to be informed about conditions in a business.

"But information alone is not enough. True understanding also depends upon *the attitude of mind* of the people concerned. Our attitude of mind is important, because it has a way of affecting the facts as we see them: it is like a pair of glasses which magically can change the color and shape of the things before us.

"For example, a man who does not believe in collective bargaining unconsciously may be unfair when the bargaining takes place. And a man who instinctively is opposed to any man's desire for a higher wage may be unable to view the facts judicially when such a raise is asked for. And an employee who instinctively 'hates the boss', without realizing it, may be unfair in his demands for changes in working conditions.

"Let us then examine our attitudes of mind to make sure that we are not unintentionally guilty of prejudices and preconceptions. To solve the problems of industrial relations, both warm hearts and cool heads are necessary. And when this condition obtains, public relations begin to be solved without much formal publicity; because a satisfied employee is almost a perfect publicity agent—or at least his wife is.

"Business and industry are not just sales, not just harvesting, not even just making a profit today; but are made up of all the intricacies of complete operation — plowing, fertilizing, crop rotation, as well as harvesting—looking to a profit in the long run, not as a chief end in itself, but as one of the tools for keeping the private-enterprise system going. It is a complex human system with both social and economic controls which must be operated intelligently for the benefit of all in the long run.

"With few exceptions, managers and employees alike believe this. They try to do, and generally do do, the right thing from a long viewpoint, but frequently in the wrong way.

"Many of us are still psychologically blind. We need more light on how to understand and get along together. More than anything else, business and industry, and the very welfare of the Nation, need the psychology of partnership."

THE Petroleum Engineer

SEPTEMBER, 1939

A PETROLEUM ENGINEER EXCLUSIVE FEATURE

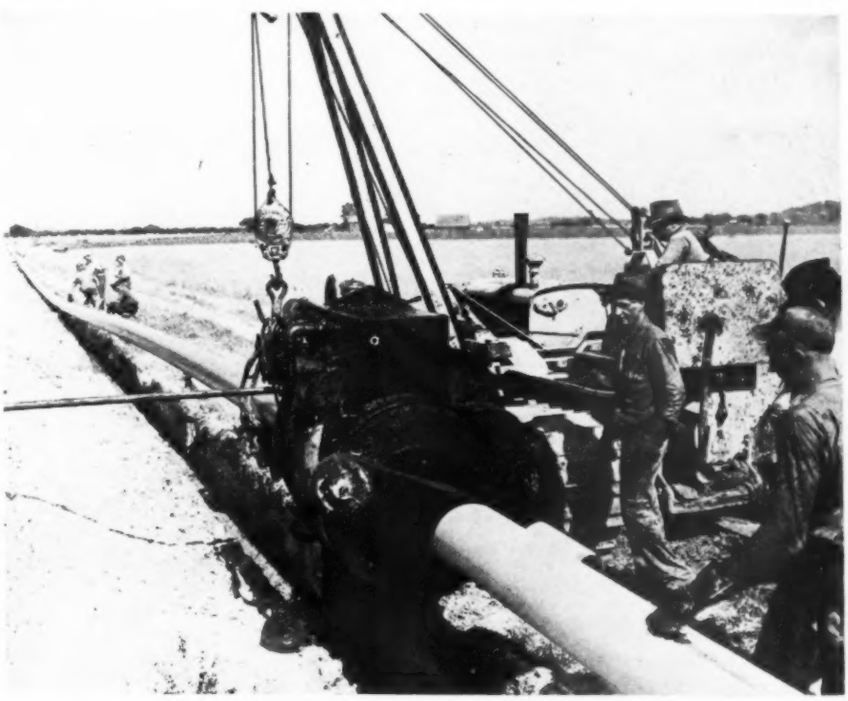
Laying of Year's Longest Oil Line Accomplished in Fast Time

Forty thousand bbl. daily capacity is added to pipe-line outlets from Illinois area by new line from East St. Louis to Lima, Ohio

By FRANK H. LOVE
Managing Editor

LAYING of the year's longest pipe line has been completed by the Magnolia Pipe Line Company for the Socony-Vacuum Oil Company, Inc., of which it is a subsidiary. A modern speed record is believed to have been established in the laying of this 356-mile, 10-in. carrier from East St. Louis, Illinois, to Lima, Ohio. The work was performed by three contractors and the exact number of working days required to accomplish the project is somewhat difficult to state because of the delays occasioned by rains and because the various crews did not begin simultaneously nor finish on the same dates. One contractor began laying pipe May 25 and finished his section on August 5; another began on May 20 and finished August 1, and the third began June 10 and laid his last section of pipe on August 10. All in all, however, it was a fast job for the amount of pipe laid.

Completion of this line provides additional pipe-line facilities for the transportation of 40,000 bbl. of Illinois crude oil per day. Besides the main line from St. Louis to Lima an 11-mile, 10-in. branch line was laid from Sandoval, Illinois, to Patoka. Crude oil from the Salem field will be transported to Patoka, where the primary pumping station has been constructed. From here it will be pumped both eastward and westward. That pumped to the east will be delivered to the Buckeye Pipe Line Company at Lima, Ohio. Its principal destination will be refineries of the Socony-Vacuum Oil Com-



This machine coated and wrapped the pipe in a single operation

Pipe on skids after being cleaned and primed

pany at Trenton, Michigan, and Buffalo, New York. Westward from Patoka oil will be shipped to Mitchell terminal and from there moved to refineries at East St. Louis and Wood River. Provision has been made for the entire load to be moved eastward from Patoka if at a later date that should be desirable.

From East St. Louis, Illinois, to a point on the west bank of the Wabash River, ten miles from Terre Haute, Indiana, the line was constructed by O. C. Whitaker Company, Fort Worth, Texas, a distance of 148 miles. This contractor also laid the 11-mile branch line from Patoka to Sandoval, Illinois. Sheehan Pipe Line Construction Company, Tulsa, Oklahoma, laid the line from the Wabash River to a point near Cicero, Indiana, a distance of 98 miles. The line from Cicero to Lima, Ohio, was constructed by T. R. Jones, Inc., Dallas, Texas. The length of this section was 110 miles. Whitaker and Jones sub-contracted the stringing of pipe on their sections to C. Hobson Dunn, Dallas, Texas, and Sheehan sub-contracted his stringing to J. L. Cox and Son, Raytown, Missouri. H. C. Price Company, Bartlesville, Oklahoma, did the electric welding of Sheehan's section of the line and Jones and Whitaker did their own welding.

J. L. Latimer, vice-president and manager of the Magnolia Pipe Line Company, supervised the entire job and L. H. True, assistant manager, was in active charge of the work. J. G. Norton, chief engineer, was designer of the pumping stations. George T. Jackson was in charge of welding inspection for Magnolia; E. A. Koenig supervised coating and wrapping of the line pipe; A. T. Glover was general superintendent of construction; J. G. Austin was assistant general superintendent of construction, and D. R. Gladney was in charge of right-of-way purchases.

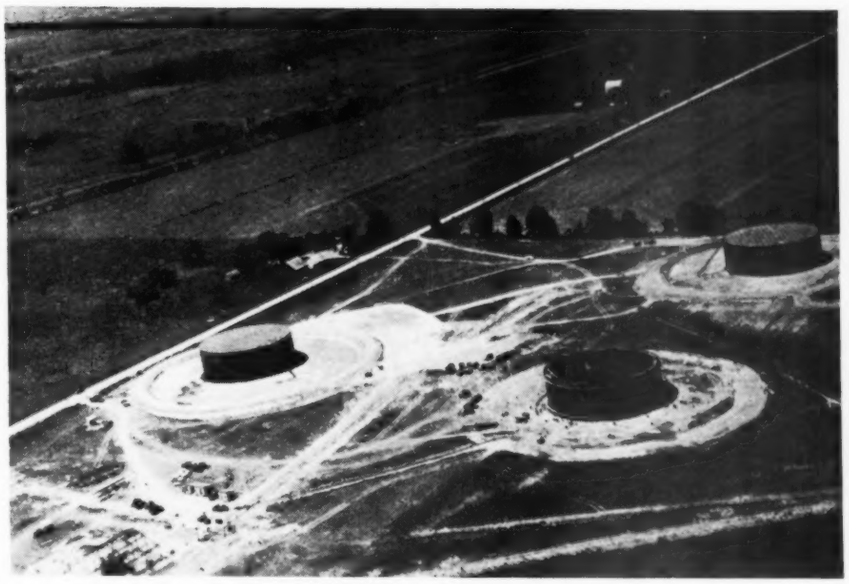
The topography of the country was favorable to rapid laying, being of a rolling nature interspersed with level stretches. The work was not without its difficulties, however. One of the principal retarding factors was the encountering of drainage tile. The country through which the line passes is a rich agricultural area entirely underlaid with drainage tile. As the location of this tile was not marked it was impossible to prevent its being cut into by the ditchers, necessitating replacement after the line pipe was lowered-in. The tile that crossed the pipe-line ditch was supported by a metal trough to prevent it from breaking when the backfill settled. The replacing of this tile represented many hours of labor. The crossing of numerous railroads and highways, the replacing of many fences, and heavy rains after the work was underway were other difficulties encountered. In addition, there were six river crossings, the widest being the Wabash River, which was approximately 670 ft.

The line was electric welded and coated throughout. The rolling-weld method was employed on the Whitaker and Sheehan sections, whereas Jones "stove-piped" his entire section of 110 miles. This latter procedure was a departure from usual practice. The "stove-pipe" method was devised originally for laying pipe in marshy, muddy, or rocky areas that made the use of a firing line impossible. This is the first known instance where it was employed on a section of line of this length and in an area where the nature of the country was such that a firing line could have been used.

In employing the "stove-pipe" method Jones used but one welding crew. This consisted of two tackers, two welders to run the stringer bead,

Ditching machine cutting the pipe-line trench

Aerial view of Patoka, Illinois, station while still under construction



and eight welders to complete the welded joints. Unusually good time was made using this method, the best day seeing 18,500 ft. of pipe laid and the poorest day 9000 ft.

Whitaker and Sheehan each employed two spreads. The former started one spread from East St. Louis and the other from Patoka, Illinois, both working in the same direction. Each crew was equipped with ten welding machines to perform the complete welding operation of tacking, roll welding, and tying-in. The greatest footage of pipe laid by one crew in an 8-hour day was 24,000 ft. Each of the Sheehan crews was equipped with nine welding machines.

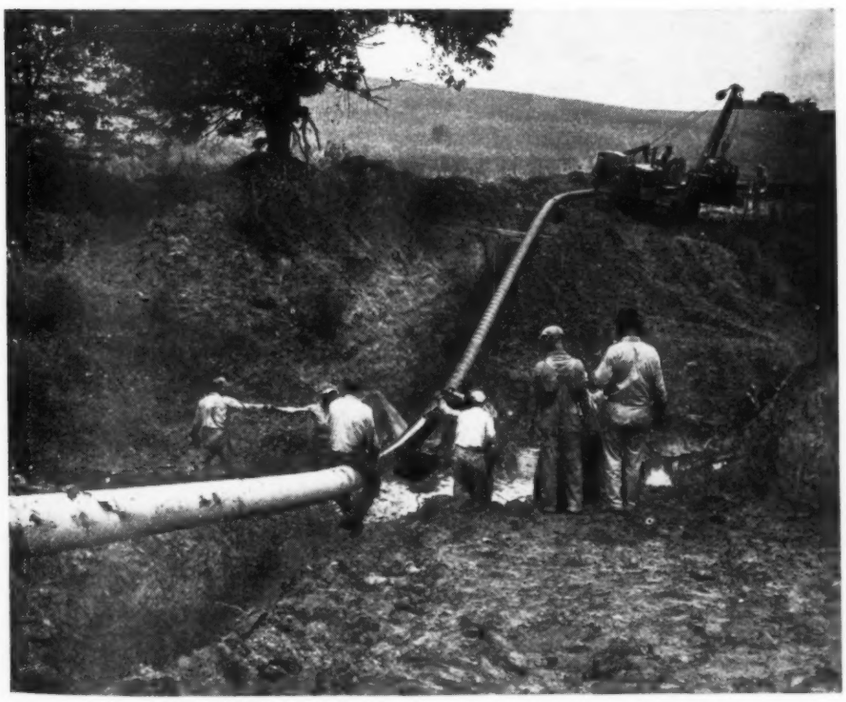
After the sections were welded into the line the pipe was left on skids above the ditch and a cleaning machine of the traveling type passed over it. To this machine was attached a priming unit that was pulled along behind. The priming equipment had a separate motor to operate its mechanism, and the complete unit could be detached from the cleaning machine when necessary to remove the latter from the line for repair or cleaning.

The line was coated and wrapped using asbestos felt and kraft paper over its entire length. Two coatings were used: a preparation similar to enamel and having a grease base, and a chemically-compounded grease-type rust preventive. The coating and wrapping were performed in one operation by a machine designed especially for that purpose and which has been in use for little more than a year. The machine rides the pipe and functions entirely by its own power, which is supplied by a small gasoline engine. This engine propels the equipment along the pipe, as well as operating the wrapping device and a pump to circulate the overflow coating from the drip pan back into the hopper.

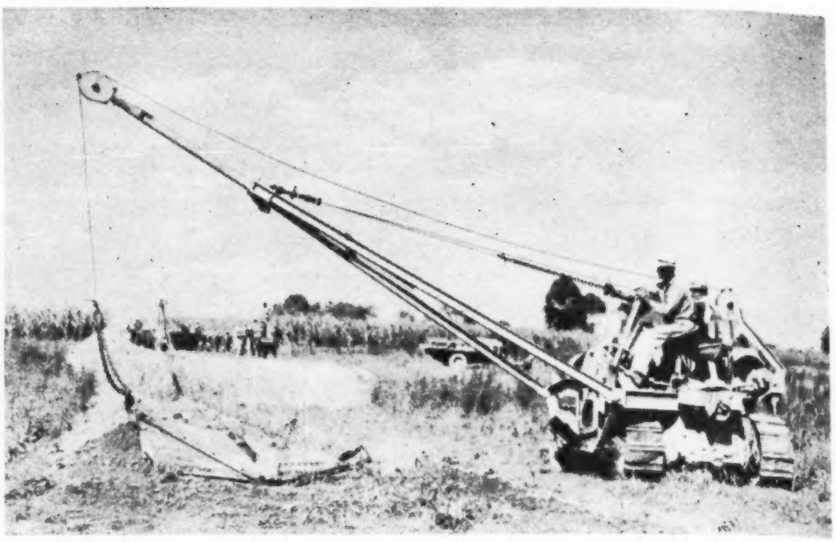
Hot coating material is poured into the hopper, which is situated at the top of the machine. A valve at the base of the hopper serves to regulate the flow and an adjustable shoe on the lower part of the machine controls the thickness of the coating. Overflow coating material is caught by a drip pan and pumped back into the hopper. A kerosene burner in the heating compartment of this pan is used to reheat the coating when it begins to cool. Wrapping with felt and paper immediately follows the application of the coating. The wrapping heads are geared to the power drive and revolve around the line pipe. The machine has a possible speed of 4800 ft. per hour. For the most part a single coating was given the pipe, perhaps 10 percent of the line being double coated.

Lowering-in was by tractors having winch lines and cradles. As the pipe was lowered-in slack loops were left-up to be lowered in the cool of the morning. This crowding of as much slack as possible into the line is customary pipe-line construction practice, having as its purpose provision for seasonal contraction and expansion of the line without damage.

Stringing the pipe, which came in lengths of from 40 to 50 ft., met with little difficulty as the right-of-way was readily accessible to good roads. Ditching also encountered few unfavorable conditions and consequently but little blasting was necessary. Some of the river bottoms were heavily timbered and trees and stumps had to be removed before the ditchers could operate. On the whole, however, it was easy enough for the ditchers to make enough ditch each day to remain ahead of the laying gangs. Whitaker employed four ditchers and dug only what ditch was required by the laying



Coating a sag by hand



Backfilling after slack loops had been lowered-in

gangs. The trench on this section of the line was cut 30 in. deep and 22 in. wide. Sheehan used two ditchers, one for each spread. They cut a trench 32 in. deep and 20 in. wide, each machine making about 5300 ft. per day. Jones employed two ditchers most of the time, at times three, each averaging about 6000 ft. per day. The trench on this section of the line was cut 36 in. deep and 24 in. wide.

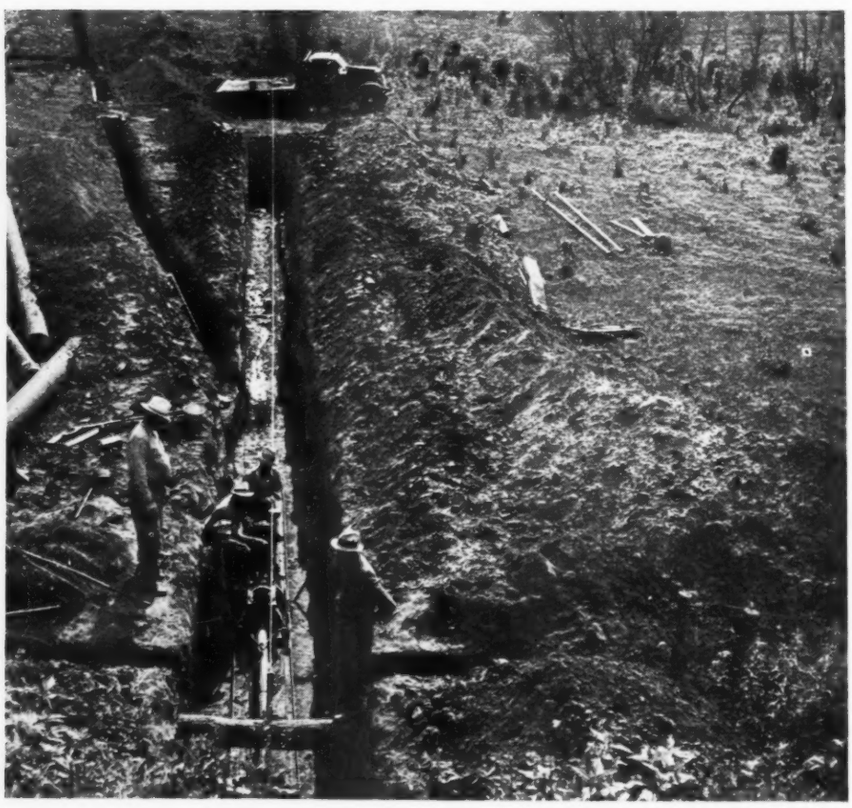
In making the numerous highway and railroad crossings customary practice was to bore the crossing and case the 10-in. line pipe with 16-in. casing. Both ends of the casing were sealed by a special bushing. All crossings were vented. Before pulling the pipe through the casing, laths were bound to it by wires to prevent damage to the coating and wrapping.

Of the several rivers crossed the widest was the Wabash. This river was crossed at a point near Terre Haute, Indiana. The work was done by Sheehan, the width of the crossing being about 670 ft. The river string, composed of extra-heavy pipe, was made-up on shore and given a double-thickness of coating material, then wrapped. River clamps were attached and laths wired to the pipe to protect the coating, after which the string was pulled into the river and tied-in on both banks. With the clamps holding the pipe on bottom the washing action of the river was depended upon to cover the pipe with silt. On some of the narrower river crossings a trench was dug for the pipe with a trench hoe.

The second widest crossing was of the Kaskaskia River at a point east of Highland, Illinois. The distance between water lines was 130 ft., but including the approaches on both banks the entire crossing totaled 500 ft. River clamps weighing approximately 2000 lb. each were spaced 15 ft. apart. The approach ditches were made using a dragline.

Only the pumping stations at Patoka, Illinois, and Reno, Indiana, have been completed. The other are in course of construction. Equipment being installed at Dieterich, Illinois, Martinsville, Illinois, and Staunton, Indiana, consists of two 415-hp., at 360 r.p.m., 4-cycle, 5-cylinder Diesel engines driving through speed increasers two 4-stage centrifugal pumps. The station at Patoka contains similar equipment. At Reno, Indiana, Westfield, Indiana, Muncie, Indiana, and Fort Recovery, Ohio, two 405-hp., 450-r.p.m., 4-cycle, 6-cylinder Diesel engines are being installed. These drive centrifugal pumps through speed increasers. The pumping station at the Mitchell terminal on the west end of the line will be equipped with two 3-stage centrifugal pumps driven by two 200-hp. electric motors. From this terminal crude oil is pumped to refineries at Wood River and East St. Louis, Illinois.

The contract for the Patoka, Dieterich, and Martinsville, Illinois, and the Staunton, Indiana, stations was awarded to A. M. Lockett and Company, Dallas, Texas; the Reno, Westfield, and Muncie, Indiana, and the Fort Recovery, Ohio, stations are being constructed by the Austin Company, Cleveland, Ohio, and the station at Mitchell, Illinois, is being built by J. F. Pritchard Company, Kansas City, Missouri.



Boring a highway crossing

P 367.3
P 425.
P 986.51

Drilling deeper by reversed oil circulation process

Determining Sand Thickness in East Texas Wells

Additional drilling required to obtain electrical log of entire section of Woodbine in preparation for proration formula based on acre-foot factor

By H. LEE FLOOD
Associate Editor

AT no other time since the early days following its discovery has interest been centered on the East Texas field as it is at the present time.

Aside from the production problems that normally engage the attention of the engineer, greatest concern in the East Texas field during recent months has revolved around the all-important problem of proration and the many questions of equitable distribution of production that are involved.

It is not the purpose here to enter into an extended discussion of the proration problem of East Texas. The entire question is an unsettled one at the present time and it may be months yet, if at all, before a definite proration plan is adopted.

The present purpose is to describe briefly the steps taken by one East Texas operator to determine accurately the total thickness of oil-bearing sand in the Woodbine formation underlying one of the company's leases on the east side of the field. The immediate purpose of the work was to prepare, insofar as the particular lease was concerned, for the possible adoption by the Texas Railroad Commission of a proration formula that would take into account the acre-foot as an element. Undertaken during the August shutdown, the work done in determining the sand thickness for possible use in proration takes on significance as an indication of the farsightedness of the operator; particularly as the Railroad Commission has only recently, in a surprise move, adopted the Hudnall formula as the basis of proration in the East Texas field. This formula will be discussed briefly following the account of the sand thickness determination.

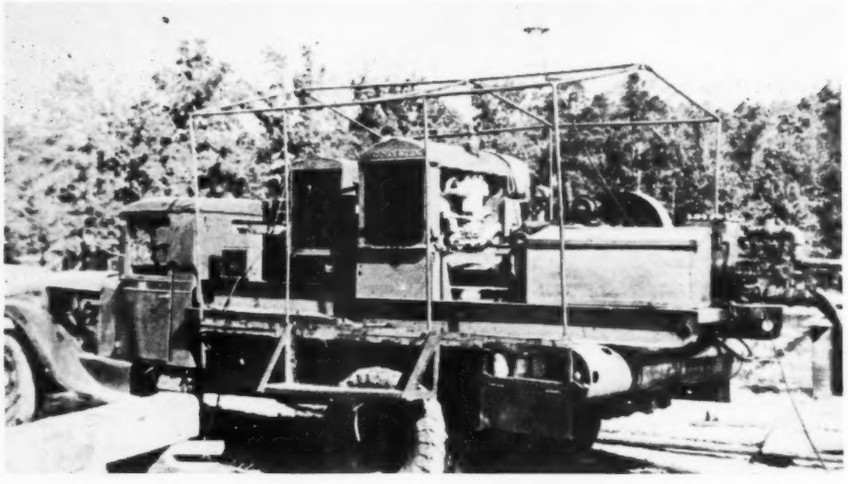
Reversed Oil Circulation Used to Penetrate Woodbine

The well selected for making the sand thickness measurement was a newly-drilled well that had penetrated the Woodbine only a few feet. Casing had been set, but the cement plug had not yet been drilled-out when the decision was made to test the entire section of the Woodbine formation.

The casing was set at a depth of 3620 ft., 5 ft. from the bottom of the hole. It was estimated that the top of the Georgetown formation immediately underlying the Woodbine would be encountered at a depth of approximately 3700 ft. The task of drilling through the entire section of Woodbine consequently required the drilling of about 75 ft. of hole.

The decision to employ the reversed oil circulation method in drilling this additional footage was based partly on the fact that the rotary equipment had, of course, been moved away and it was not considered advisable or economical to use standard cable tools to drill the necessary footage. The knowledge that considerable shale having a tendency to heave would be encountered was perhaps the principal factor against employing cable tools but pointing definitely to the advantage of using the reversed oil circulation process to guard against the shale heaving and preventing the electrical survey from reaching bottom.

Only a few hours were required to rig-up the portable equipment to be used in the reversed-oil drilling method. The cement plug was then quickly drilled-out beginning late one afternoon and by the next afternoon, drilling at the rate of about 5 ft. per hour, the top of the Georgetown had been reached at a depth of 3701 ft. Although the objective of penetrating the Woodbine had been accomplished, the Georgetown was penetrated an additional five ft., so that the electrical log would indicate definitely the bottom of the Woodbine sand.



The pump-truck carries the engine-driven pump and generator

Drilling Equipment—Reversed-Oil Circulation Process

The hoist truck that serves as the drawworks has the hoist mounted on the truck-bed so that it may be placed in working position by backing-up the truck to the edge of the derrick in line with the crown block. The hoist used is large enough to serve for 5000-ft. wells or deeper if additional lines are threaded between the blocks. The hoist is powered by a 90-hp. gasoline engine.

Another truck termed the pump truck serves to transport and support during drilling, the circulating pump and the generator unit supplying power to the drilling motor. The 4-in. by 6-in. pump is powered by a 55-hp. gasoline engine. The 10-kw. generator is powered by a 40-hp. gasoline engine.

The supply of oil used as drilling fluid is transported to the site in a tank mounted on a trailer pulled by the pump truck. During drilling, the trailer is placed a short distance from the pump truck to serve as a circulating "pit".

The normal procedure in drilling by this method is to use 2-in. or 2½-in. tubing as a drill string, to the lower end of which a special tubing bit is attached. Attached to the upper end of the tubing string is a special hexagonal kelly driven by a totally-enclosed worm-drive connected to the drilling motor by a tubular shaft and two flexible couplings. The worm drive is an integral part of the head used to pack-off the casing.

The position of the 7½-hp. electric drilling motor is as shown in an accompanying illustration. Electric power in this particular application has proved very satisfactory. Not the least of its advantages is the insurance it provides against a torque great enough to twist-off or otherwise damage the light tubing-drill string. Not only will the motor stall before the load exceeds the strength of the tubing but a most sensitive weight indicator is provided in an ammeter that records each slight change in the load. The ammeter may be seen to the right of the motor mounted on a vertical board so that it may be read easily by the driller. A light mounted directly above the dial is used at night.

Reversed circulation is, of course, a departure from normal drilling procedure in that the drilling fluid is pumped down the casing and is returned to the surface through the tubing or drill string. The principal and most obvious advantage is that a much higher upward velocity will result using a given volume or rate of oil circulated when the fluid returns through the smaller area of the tubing. High velocity is essential, of course, in lifting and keeping suspended the drill cuttings that must be removed constantly from the well-bore. More important from the equipment standpoint, less power and consequently smaller equipment is needed to maintain the desired velocity.

Oil as a circulating medium has been proved to have definite advantages in the type of work usually done by this method of drilling. In drilling shale known to have a heaving tendency as in the well described, oil is definitely superior to a fluid containing water. Water has a deteriorating effect on shale whereas oil has little if any effect on this type of formation. In fact, there apparently is a tendency for oil to "slick-over" and dress-up the walls of the hole so that danger of the shale heaving is minimized.

Electrical Log Determines Sand Thickness

Following completion of the drilling, 20 bbl. of drilling mud was introduced into the well to displace the oil in preparation for the electrical survey of the Woodbine. The smaller or tubing-size "torpedo" or detector was used in order to run the cable and the instrument through the 2-in. upset tubing string.

Some apprehension was expressed as to whether the survey could be made as deep as desired. This fear was based on the possibility that shale might have "sloughed-off" and filled-up the hole.

The survey was carried successfully, however, to the bottom of the hole and an excellent record was obtained of the entire Woodbine formation. Very definite changes in the readings were recorded, which, when correlated, indicated clearly the oil-bearing sections of the zone. A total "pay" section of 22 ft. was logged by the survey. This information will prove extremely valuable in connection with proration involving the acre-foot factor.

The Hudnall Formula

Of the various proration formulas that have been proposed from time to time as a basis for allocating production in the East Texas field, the Hudnall formula is of greatest interest at the present time because of its adoption on September 11 as the basis for East Texas proration.

Proposed by J. S. Hudnall of Tyler, Texas, during his testimony before the Railroad Commission on August 23 the formula may be expressed as follows:

$$\frac{AF_l \times Po_l \times Pr_l}{AF_f \times Po_f \times Pr_f} = \text{proration factor}$$

in which:

AF_l = avg. acre-ft. of oil sand under lease.

AF_f = avg. acre-ft. of oil sand under entire field.

Po_l = avg. potential per well on lease.

Po_f = avg. potential per well in entire field.

Pr_l = avg. bottom-hole pressure under lease.

Pr_f = avg. bottom-hole pressure of entire field.

Hudnall's calculations were based on a top allowable of 490,000 bbl. per day in a 7-day week or 686,000 bbl. per day in a 5-day week. This allowable has been adopted by the Commission in its new order.

The formula adopted in the order allocates a 20-bbl. daily allowable to all wells in the field and provides for distribution of the balance of the field allowable in accordance with the percentages obtained by use of the formula. It is estimated that the basic allowable of 20 bbl. per well will total 515,000 bbl. per day, leaving 171,000 bbl. daily for proration under the formula.

The Absorption Process of Natural Gasoline Extraction

The absorption method has demonstrated its efficiency and flexibility for a wide range of pressures and varying degrees of gasoline content

By ROY W. MACHEN, Hamman Exploration Company

THE total daily capacity and the number of natural gasoline plants decreased in the United States between May 1, 1932, and May 1, 1935. During this period, however, the individual daily plant capacity increased each year.

Since 1935, the number of plants has steadily decreased each year to only 652 as of May 1, 1939. The total daily production capacity of all plants at present is 10,882,481 gal., and the average individual plant daily capacity is 16,691 gal.

Fifteen years ago there were 1012 plants in the United States having a combined daily capacity of 3,396,961 gal., and an average daily plant production capacity of 3,356 gal.

The major portion of natural gasoline production is processed in the absorption-type plant. Texas and California have 63 percent of the total natural gasoline production capacity in the United States. Of this 6,951,550 gal. daily capacity, 79 percent is classified as of entirely the absorption type. In addition there is a portion of the production capacity classified as compression-absorption that, if included, would tend to raise the percentage of absorption capacity.

The absorption process of natural gasoline extraction has proved its merit in its efficient and flexible application to virtually the entire range of pressures and gasoline content. Absorption plants now in operation or in construction are designed for service at pressures of from 1000 to 1500 lb. This method of extraction has been coördinated satisfactorily with many of the newer and swiftly advancing process methods.

The absorption plant consists primarily of three separate and distinct processing units. This excludes the auxiliary equipment preceding the gas inlet scrubber and following the residue gas back-pressure manifold.

In the absorption plant it is necessary first to extract the gasoline vapor from the rich gas entering the plant by absorption; second, to remove the gasoline from the absorptive medium by distillation, and finally, to prepare the raw gasoline for market by stabilization.

ROY W. MACHEN

received a bachelor's degree from Oklahoma City University in 1927—Employed for six and one-half years by the Peppers Gasoline Company as refinery clerk, refinery and gasoline plant chemist, and gas engineer—The last five and one-half years have been spent in the service of various independent refining companies as gas engineer, operator in high-pressure gasoline plants, refinery construction engineer, and superintendent of refinery operations—He is a registered petroleum and natural gas engineer.

The removal of the condensable gasoline fractions from the gas is accomplished by the intimate contacting of the absorption medium, in most cases, absorption oil, with the wet gas. This contact is made in a cylindrical column called an absorber. The modern absorber is essentially a "bubble-tower" and is usually fitted with conventional trays, or plates, supplemented by the customary vapor risers covered by caps, and overflow pipes, or downcomers.

There are still a great many absorbers of the "filled type" in use in the older plants. Columns so classified are usually packed by special ceramic material such as the Raschig ring; however, this type absorber may be filled with steel filing or shavings, broken brick, or various other materials to break-up the downward flow of the oil and the upward passage of the gas and in so doing cause an intimate contact. This type absorber will have a very low first cost but the tendency for the oil and gas to channel, that is, for the oil to descend by one route and the gas to rise by another through the filling, is a very serious disadvantage. This type column is also characterized by a very low throughput capacity.

The plate tower is much more efficient. The simplest form of tray that will give a reasonably high extraction efficiency is the "perforated plate." This plate has a large number of holes drilled in it. The pressure and velocity of the gas passing upward through the holes prevent the oil from dropping to the next tray below except by way of the downcomers, provided for that purpose on each tray. The downcomers extend above the surface of the plate and this projection determines the constant depth of the contacting liquid on the tray. This type column is objectionable because it has to be operated at more or less the same capacity as a fixed velocity must be maintained or the liquid will drop down through the perforations in the plate rather than through the overflow pipes. Another disadvantage is the possibility of clogging by rust or other foreign matter. A perforated-type plate that eliminates these objections to a great extent is one having drilled holes in which a loose rivet has been inserted. As the gas velocity increases the rivet slips upward in the hole permitting an increased cross-sectional area for the rising gas. As the velocity is diminished the rivet drops downward into the hole until the openings are virtually closed.

The "bell-cap" or "bubble-cap" plate has been developed to overcome the objectionable characteristics of

other plate assemblies. This type plate affords flexibility in column capacity and at the same time does not sacrifice the contacting intimacy essential for the successful and efficient processing of petroleum fractions. The trays are drilled for a number of vapor or gas chimneys and each chimney is covered by a cap secured in place. The uprising gas or vapor passes through the chimney, impacts against the inside of the cap, breaks downward between the sides of the cap and the vapor chimney, passes out through the slots or serrated edges of the cap's skirt, and bubbles through the liquid on the plate before ascending to the next tray above. The surplus liquid on each tray drops through the overflow pipe, set to hold a predetermined constant depth on the plate, to the deck below. On the lower deck, the overflow pipe from the plate above is surrounded by a wall, or weir, which holds the liquid level around the downcomer slightly higher than the level of the liquid on the tray proper. The overflow pipes are usually arranged so that the downcomer on each successive plate is diametrically opposite the position of the one from the tray above. The pressure and volume of the gas and oil to be processed determine the detailed arrangement of the plate assembly.

In one plant, the analysis of the residue gas from one 40-ft. bubble-cap-type absorber that had replaced three 60-ft. filled-type absorbers indicated not only a better stripping of the gas, but also that this higher efficiency could be obtained with much less oil circulation.

The absorption oil, sometimes called gas-oil or mineral seal oil, falls into two main classifications. That which is called heavy or mineral seal oil is used in the old type steam still. The light oil, which is really nothing more or less than a narrow boiling range kerosene, is used in plants having steam stills of later design permitting a closer fractionation between the raw gasoline and lean oil. The determining factor in the final selection of the absorption oil to be used is the still. Many times the pressure and percent overload on the absorber capacity have a great influence on this selection.

As a general rule, the initial boiling point of the oil should be as low as possible. The boiling range of the oil is sometimes as narrow as 150°F. but it is more usual for it to spread over a 200°F. range. An ideal oil is one that has a low gravity, low molecular weight, and narrow boiling range having the endpoint as low as possible.

The heavy absorption oil is usually approximately:

Gravity	36-38 deg. A.P.I.
Initial	475°F.
Endpoint	600°F.
Mol. wt.	215-220

The light absorption oil is usually approximately:

Gravity	40-44 deg. A.P.I.
Initial	375°F.
Endpoint	500-525°F.
Mol. wt.	170-175

The absorption oil is introduced into the absorber on the top tray; thence it passes downward through the column from tray to tray and from one side to the other successively. The rich gas enters the column just below the bottom deck and rises from tray to tray until it passes out overhead through a line leading to the residue gas scrubber wherein any entrained absorption oil is dropped-out and later returned to the system. The gas, stripped of its gasoline content, passes overhead from the residue scrubber to a back-pressure manifold that automatically controls the pressure on the absorption system. The residue gas is disposed of in various ways.

The bottom deck is placed in the column approximately 5 or 6 ft. from the base. In this way a reservoir for the rich oil is provided. The level of the rich oil in the absorber base is held well above the oil outlet connection by a liquid-level control actuating either a throttling valve in the steam supply line to the rich oil pump or a control valve in the rich oil discharge line from the absorber. The placing of the control valve is dependent on the operating pressure of the absorber system.

As the lean oil enters the absorber and is contacted by the gas, it takes on a frothy state and changes from a smooth liquid to a gaseous foam of literally millions of bubbles. Each of these small gas bubbles is surrounded by a thin film of oil that "sucks" the gasoline fractions away from the virtually non-condensable gases, methane and ethane, and the undesired portions of the propane and butane components.

As the lean oil progresses downward through the tower, it becomes richer and richer in gasoline liquid content. At the same time, as the rich gas progresses upward through the column, it becomes leaner and leaner in gasoline vapor content until it flows out overhead as a "dry" or residue gas.

As the vapor pressure of hydrocarbons increases as temperature increases, it is desirable to keep the temperature of both the oil and gas as low as practicable. As it is the temperature of the oil leaving the absorber that has the most direct bearing on the absorption efficiency, in many plant installations provision has been made to remove the oil after it has dropped a few plates through a "propane-butane" chiller and then return the oil to the absorber on a lower plate. This oil removal, cooling, and subsequent return at a lower temperature results in an increased absorption efficiency and a smaller circulation of oil for the desired recovery. It has been found in some instances that a 10 percent decrease in oil temperature will permit a 20 percent decrease in oil circulation.

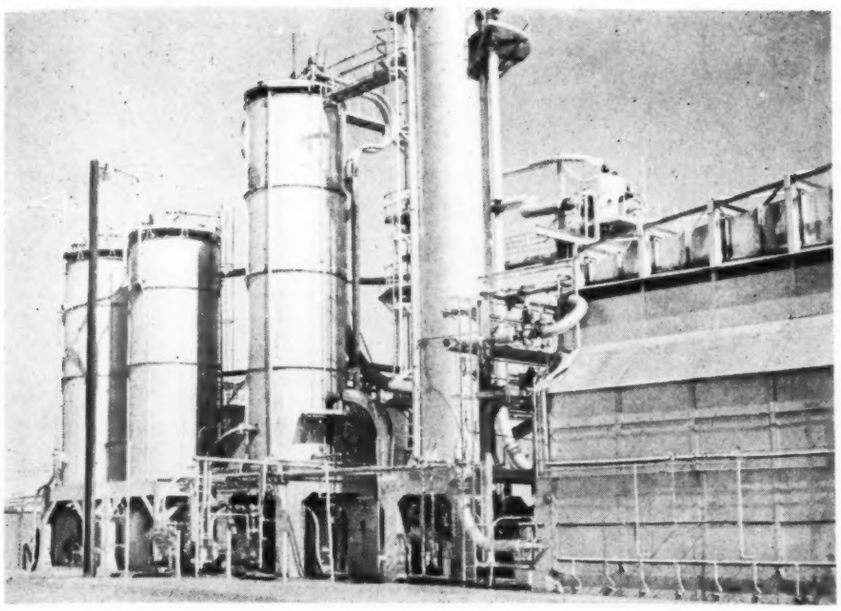
As the driving force of any compound is its partial pressure in the gas, it would seem that the higher the pressure at which the absorber is operated, the greater the tendency of the component to be absorbed. This has not been found to be the case when absorber operation is at or near 1000 lb. but at present such high-pressure operation is in its infancy.

The quality of the oil in sludge and residue content has a direct bearing on circulation. The larger the percentage of high-boiling residues and sludge, the higher the oil circulation must be for efficient extraction. A special unit is installed by many plants to strip the oil continuously of this sludge and residue.

The oil-gas ratio has been found by many plant operators to be most efficient at some definite point. When the ratio was higher or lower than that point of maximum effect, the absorption of large amounts of undesirable fractions or the passing out of small portions of the n-butane as residue gas resulted, respectively.

It has also been found that the best absorption and maximum gasoline recovery is obtained when the lean oil entering the absorbers is maintained at some definite temperature. The temperature of the oil entering has a direct influence on the rich oil. In the absence of intermediate coolers on the oil cycle through the absorber, the control of the temperature of the oil to the absorber to obtain the temperature at which maximum extraction occurs is desirable. In cases when intermediate coolers are in service, temperature control of the oil leaving the absorber would be preferable.

The rich oil in most cases is taken from the base of the absorber and pumped into a vent tank. This is of course imperative in the case of high-pressure absorption. Here the small amounts of non-condensable gases contained are released from the rich oil by a reduction in the pressure under which the oil is held. The gases released overhead pass into a low-pressure or "tail" absorber wherein any condensable fractions carried out may be reabsorbed.



Processing vessels in Big Spring, Texas, refinery of Cosden Petroleum Corporation

A PETROLEUM ENGINEER EXCLUSIVE FEATURE

By
J. C. ALBRIGHT

Plant at Big Spring designed for operation on reduced crude oil, a combination of reduced and fresh crude, or on straight fresh crude oil

Efficient Cracking of West Texas Sour Crude Oil

AFTER a year's operation, the 6500-bbl. refining unit added by Cosden Petroleum Corporation to its Big Spring, Texas, plant has demonstrated its efficacy in processing the sour crudes produced in the area. Through a series of additions and improvements during the years this plant has been in operation, it now is the largest refinery in West Texas. Completed in June, 1938, the new addition increased the plant's capacity to 17,000 bbl. per day.

The new unit may be operated on reduced crude oil, a combination of reduced and fresh crude oil, or on straight fresh crude oil alone, depending upon the stocks on hand and the results desired. The refinery now includes equipment for finishing all products manufactured from Howard-Glasscock or other West Texas crude oils produced from the Permian Basin.

When operated as a combination plant, processing a mixture of topped and freshly produced crude, the topped material is charged directly to the absorption column, entering in the conventional manner over the top tray, and traveling downward countercurrently to the flow of uncondensed vapors from (1) the reflux accumulator of the main fractionating column in the cracking plant, (2) the pressure distillate receiving drum, and (3) the final stabilizer reflux accumulator. The fresh crude, in quantities to balance the load on the cracking plant, is charged directly to the main fractionating column, entering as a combined stream with the enriched topped crude pumped from the base of the absorption tower. The enriched topped crude, however, first passes normally through a heat exchanger installed on a split stream from the main fractionating column to balance the temperature of the column and to reduce the load on the reflux accumulator condensing sections. If necessary for optimum cracking results, bypasses installed in the charging lines may be used to divert the full stream of both enriched topped and freshly produced crude oils directly to the main column, either above the stripping trays or into the base to be mixed with the heavier stocks refluxed from the trays. Under normal operating conditions the combined charge is introduced above the seven stripping trays.

A vertical, 8-cylinder gas engine operating at 400 r.p.m. connected through a geared speed increaser to a centrifugal pump revolving at 3600 r.p.m. removes the hot oil from the base of the main fractionating column and delivers it to the tubes of the furnaces at the required volume and processing pressure.

The furnace equipment for processing the heavy hot oil consists of two heaters of the modified equiflux type, having center bridge-walls, and double-

J. C. ALBRIGHT

after participation in the World War, was drilling superintendent for H. J. von Hagen in North Texas area, 1919-1921—With the Noble Oil and Gas Company, Burkburnett, Texas, in the natural gasoline and refining departments, from 1921 to 1923—Joined staff of the Dixie Gasoline Company in 1923 and became Texas manager—Employed by Phillips Petroleum Company in 1925 and was sent to New Mexico as special representative at Artesia where the company constructed a natural gasoline plant—Made state representative by that company in 1926—Left Phillips in 1929 and for a time operated as a consulting engineer, having offices at Brownwood, Texas—For last ten years has devoted virtually all his time to free-lance writing for trade journals.

side up-shot burners in the floor of the combustion chambers. Each heater has a double set of processing tubes, hung on the outer walls. Connections in the line from the hot oil pump provide for splitting the stream in four equal amounts, controlled in volume by automatic flow controllers. The tubes in these heaters are 26 ft. long. Both 2⅝- and 2¼-in. diameters tubes are installed to maintain velocity to prevent excessive coking. The arrangement of the heaters provides, in effect, four separate furnaces for obtaining the required temperature for optimum cracking of the heavy hot oil charged to the unit. After passing through the tubes of these heaters, the material in process is combined in a common transfer line leading to the top of the reaction chamber as if only one large cracking furnace had been installed.

The light oil is pumped by a unit similar to the heavy oil unit described. The pump takes suction from the side of the main fractionating column of the cracking plant opposite the tray at which a fractionated product having an end point of 600°F. may be obtained. The product is accumulated directly from the column in a receiver from which a vapor line returns to the column and fractions unstable at the temperature of the material in the receiver. The pump delivers this material to two furnaces, smaller in outward appearance to the heavy oil heaters, but each is equipped with only one continuous coil of tubes, suspended by hangers on the outside walls. The interior construction of these furnaces provides a center bridge wall having two sets of burners, one on each side of the center wall, for more efficient distribution of heat. A transfer line connects both furnace outlets to a nozzle in the reaction chamber and provides for blending with heavy oil to obtain a maximum volume of high octane gasoline.

The homogeneous mass of vapors resulting from processing the charges of heavy and light oil in the four furnaces is released from the base of the reaction chamber through a pressure-reducing valve. The valve stem is connected by a set of shafts, universal joints, and gears to a hand wheel on the instrument panel of the control room to provide precise pressure control. Cool oil in quantities sufficient to arrest cracking is introduced into the stream of vapors down-stream from the pressure-reducing valve, and the entire mass enters the flash chamber for the removal of lighter vapors from the heavy residuum. Residuum to be marketed as industrial fuel oil is pumped from the base section of the flash chamber, is cooled, and transferred to storage.

The vaporized portion of the material leaving the flash chamber enters the main fractionating column of the unit below the stripping and fractionating plates, joining the vapors from the combined charge previously described. Only one commercial cut is removed from the main fractionating column—pressure distillate from the top vapor outlet. Side cuts may be taken when desired, but the usual procedure is to charge the side product to the light oil heaters, and return the base product to the heavy oil heaters for cracking.

The overhead vapors are split in stream, a portion being cooled in exchange with the enriched topped crude oil and condensed for reflux, which is pumped back over the top of the column in producing commercial gasoline. Most of these vapors are condensed in separate sections to form the product used for blending to obtain high-octane gasoline. Condensed pressure distallate may be run directly to storage if necessary, but in normal operating procedure, it is stabilized to a specified vapor pressure by the removal of low-boiling constituents in the stabilizer column.

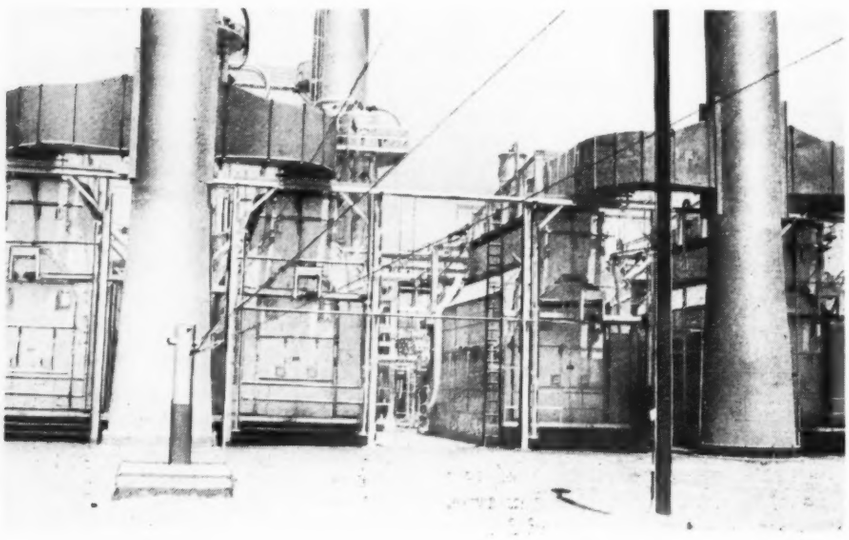
When stabilizing the pressure distillate to vapor pressure specifications, the raw distillate is pumped from the overhead distillate accumulator drum on the main fractionator column through exchangers, flowing countercurrent to the finished product from the base, to increase the temperature for efficient stabilization. The construction and operation of the stabilizer is conventional. The heating for the column reboiler section is obtained by exchange from a stream of light oil taken from the main fractionating column and is returned to make up a stream of cooling and wall-washing material when required. All vapors from the stabilizer and those leaving the pressure-distillate accumulator drum and the main column reflux accumulator enter the absorber for recovery of valuable fractions not retained in other phases of the process.

The stabilized material is pumped from the base of the stabilizer through a complete treating plant including a lime-wash apparatus wherein a saturated solution of hydrated lime and water is used for the removal of H_2S. This material is used until it shows signs of weakening, and is then replaced by a fresh charge. After contact with the lime wash, the distillate in contacted by a caustic solution to eliminate mercaptans, then is finished in a doctor plant for sweetening.

Automatic control is employed throughout the plant. Instruments connected to the charge pumps, reflux pumps, and other pumps in the plant are synchronized so that a smooth flow of the material in process is obtained at all times. A method of controlling furnace fires in relation to transfer line temperature results in only a small degree of variation in the temperature of the material leaving the furnaces.

The gas engines driving the centrifugal pumps already described are cooled by a closed system containing distilled water.

The crude oil processed in this plant is sour, as are most West Texas crudes. The experience accumulated throughout the years of operating on Howard-Glasscock and other corrosive oils has been of inestimable assistance in designing the latest unit installed. The new unit was constructed of materials developed to withstand such abnormal working conditions.



Stack end of heaters in cracking plant

P 422.343

Proposed Layout for a Four-Engine Rotary Rig Drive

Four Diesel engines are arranged to provide ample flexibility for all combinations of pump and table speeds

By F. ERICH BRUHN
Consulting Diesel and Mechanical Engineer

ALTHOUGH the operating economy has in recent years caused a continual increase in the use of Diesel-engine-driven rotary rigs, there is still to be desired in these rigs more flexibility and reserve power. In approaching the flexibility of steam-driven rigs, the Diesel-electric rig has been the most successful, but this type of drive is extremely complicated for general oil-country use, aside from the fact that the first cost of this type of rig drive is considerably higher than the straight mechanical rig.

Two-Engine Rigs

To the present time nearly all engine-driven rigs have been powered by two internal combustion engines. In most cases these two engines have been of equal type and size. The principal disadvantage of this combination in the past has been the necessity of compounding both engines when drilling to obtain the maximum horsepower output. This is because, when drilling, the power required to drive the rotary table is so much less than the power required by the slush pump. When the two engines are compounded for drilling operations it is often impossible to obtain the desired table speed for the best drilling performance, and still maintain desired pump speed. The result of this condition when the engines are operated independently is an overload on the pump engine and the table engine is doing little more than idling. This objection has been eliminated to some extent by the use of drawworks having a series of forward speeds, which further complicates the equipment and its maintenance, and even then does not at all times provide the proper combination of desired pump and table speeds at a given engine speed, when the engines are compounded. Further, in the event that one of the two engines fails in service, it is in most instances impossible to carry on drilling operations effectively. Usually it is possible to get the bit off bottom and to avert caving but one engine alone will not satisfactorily operate both the slush pump and the rotary table on a rig that is designed to use both engines for normal drilling operations.

F. ERICH BRUHN

received the degree of engineer of mines from the Colorado School of Mines in 1922—Was employed for several years by western mining concerns, then by the Ingersoll-Rand Company as sales engineer in the Southwest—Was on the staff of the Oil Well Supply Company and later was with the National Supply Company—While with the latter his duties were in connection with sales and engineering of Diesel and gas engines as applied to oil-well pumping and cable-tool and rotary drilling, during which assignment detailed studies of power requirements of various types of pumping and drilling equipment were made—At present resides in El Paso, Texas, and practices Diesel and mechanical engineering as a consultant.

On some rotary rigs powered by two engines, one engine has more capacity than the other. In this combination, the smaller engine usually operates the rotary table through the drawworks and the larger engine drives the slush pump. When removing or replacing drill pipe both engines are compounded, as in the conventional type of two-engine rig having equal-sized engines. In the event of failure of the smaller engine, normal drilling operations can often be carried on until the smaller engine is returned to service.

In the event, however, of failure of the larger engine, which is usually more likely because it operates more nearly loaded, drilling operations would cease. The table engine would not have sufficient power to drive both the pump and the table, and in many instances could not drive the pump alone.

Aside from the operating disadvantages of the two-engine rigs discussed, there are also the disadvantages of usually having to move each engine and its extended drive separately when rigging-up in a new location. This increases cost of moving and rigging-up. Also, as the engines are moved separately, more time is required to line-up the engines and drive than would be needed if the engines and drive could be moved as one unit. There are lightweight rigs, which can be moved as a unit, but the proposed rig to be discussed is for heavier drilling, requiring up to 500 hp.

Four-Engine Rig Is Proposed

To eliminate some of the many disadvantages of the two-engine rig, the four-engine rig is proposed. The accompanying drawings show the general plans for the assembly of this rig.

It is proposed to use for this rig drive four 6-cylinder, 90-hp. Diesel engines operating at 1200 r.p.m. In order to keep weight and overall dimensions at a minimum 2-cycle engines are recommended, but they should be equipped with a blower and mechanically-operated exhaust valves for scavenging to obtain 4-cycle operating economy. These engines are conservatively rated at 90 hp. at a piston speed of 1000 ft. per min. (1200 r.p.m.) but they will actually develop at this speed a maximum of 125 hp. By operating the engines and extended shafts at a speed of 1200 r.p.m., disk-type clutches can be utilized throughout the entire drive, eliminating the difficulties often resulting from the use of jaw clutches on this type of drive.

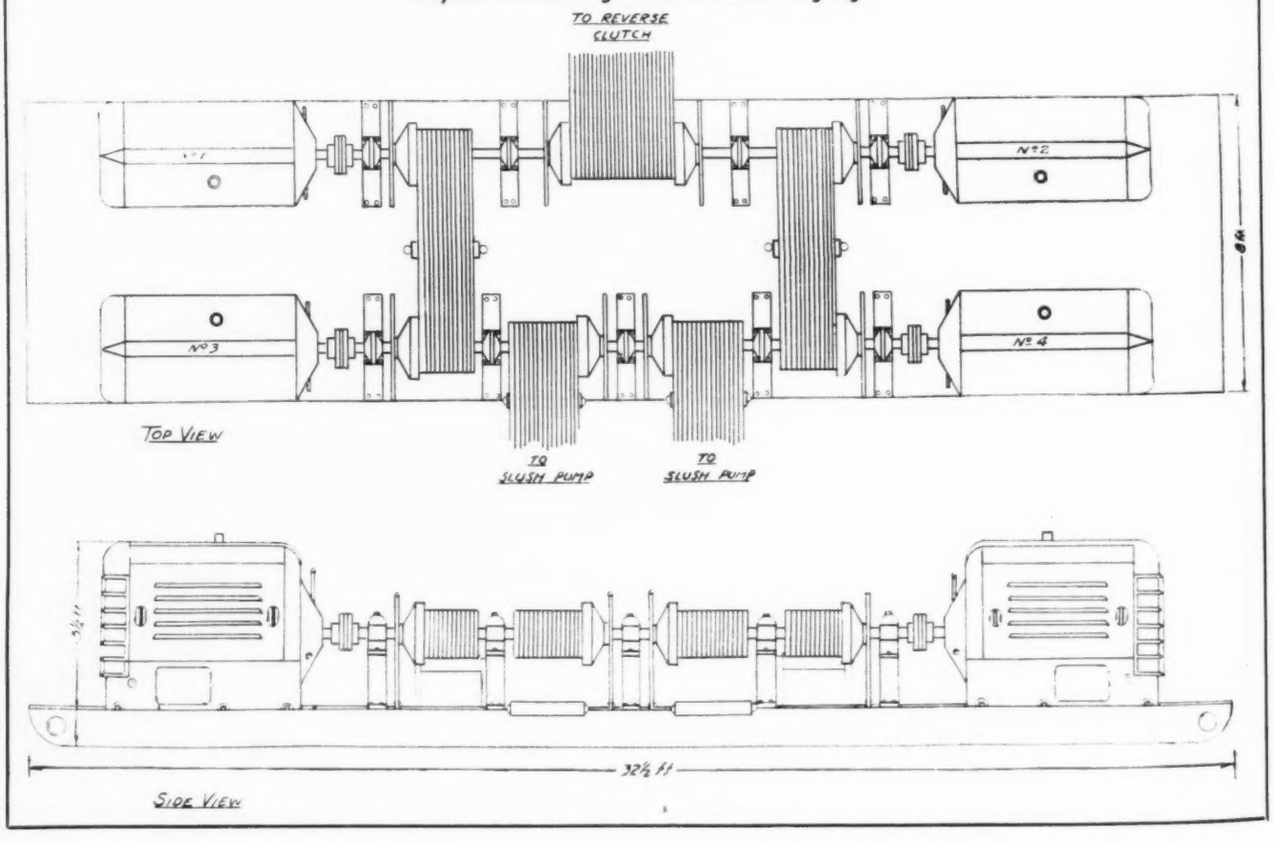
The flexibility of this combination of

four engines can be readily appreciated. As this rig may be used with a drawworks having a limited number of forward speeds, it may be desirable to operate either engine no. 1 or engine no. 2 to drive the rotary table through the drawworks, and to compound the other engine with engine nos. 3 and 4 to drive the slush pump. In this combination the shaft between engines no. 1 and no. 2 should have clutch couplings between the sheave for the countershaft drive and the compounding sheaves on either side. This set of clutch couplings has not been shown on the layout diagram, but would be placed as described. This arrangement permits the operation of engine nos. 1 and 2 at independent speeds. Only one continuous shaft is required between engine nos. 3 and 4, as neither of these engines will be required for table drive, and in the event both are operating, they will run at equal speed as both will be driving the slush pump. The various combinations of drive that can be obtained are apparent, but too numerous to tabulate. For normal drilling operations, either engine no. 1 or engine no. 2 may be used for driving the rotary table through the drawworks independently. The slush pump will be driven either by any two or by all three of the remaining engines. For hoisting operations all four engines are compounded, if necessary. Otherwise, any lesser number that will handle the load requirements may be used. With this rig, a slush pump that will operate satisfactorily at a maximum horsepower input of 250 hp. may be used. Two pulleys and clutches are recommended on this rig for slush-pump drive, so that two slush pumps may be belted to the rig drive. This is to take care of pump failure and eliminate delays that would be encountered in the event of the failure of one slush pump if no standby pump were available.

If desired, a fifth engine of the same size and type could be used to drive the rotary table direct and eliminate the necessity of driving through the drawworks. This is particularly advantageous when high table speeds are desired. All sheaves on this proposed rig drive have a pitch diameter of 15 in. The sheave for driving the drawworks through the reverse clutch countershaft has 24 grooves and has a disk clutch at each end. This minimizes the severe shock loads on each clutch, and provides "standby" clutch capacity for drilling operations in the event of failure of either clutch. All other sheaves have disk-type clutches on one side only. The compounding sheaves are all 12-groove and the two slush-pump drive-sheaves are each 15-groove. "D" section V-belts are used on all sheaves. As the engines are firmly secured to the sub-base, two belt tighteners are provided to compensate for belt stretch between the engines.

By utilizing well-balanced, 2-cycle, high-speed engines for this proposed rig drive, the weight is materially reduced as compared to the conventional two-engine rig drive. The entire drive, including the four engines, V-belt sheaves, V-belts, clutches, pedestal bearings, flexible couplings, extended shafting, and all steelwork in the sub-base, will weigh less than 25,000 lb. The entire assembly can be moved as one unit. It is only necessary to remove the V-belts from the reverse clutch and the slush pumps. Particular attention is called to the fact that the overall width of the entire assembly is only 8 ft., which allows it to come within the load-width limits in all oil-producing states. Rigging-up time for this rig drive is materially reduced compared with that required for the conventional two-engine type drive. Engines have radiator cooling, electric starters, and to place them in operation it is only necessary to connect the fuel tank that is transported separately. The fuel lines are manifolded so that only one suction line is required for the entire assembly.

Layout of four-engine drive for drilling rig



THE ORIGINAL clip type valve with drain channels and bronze bonnet-thread-bushing . . . . . .

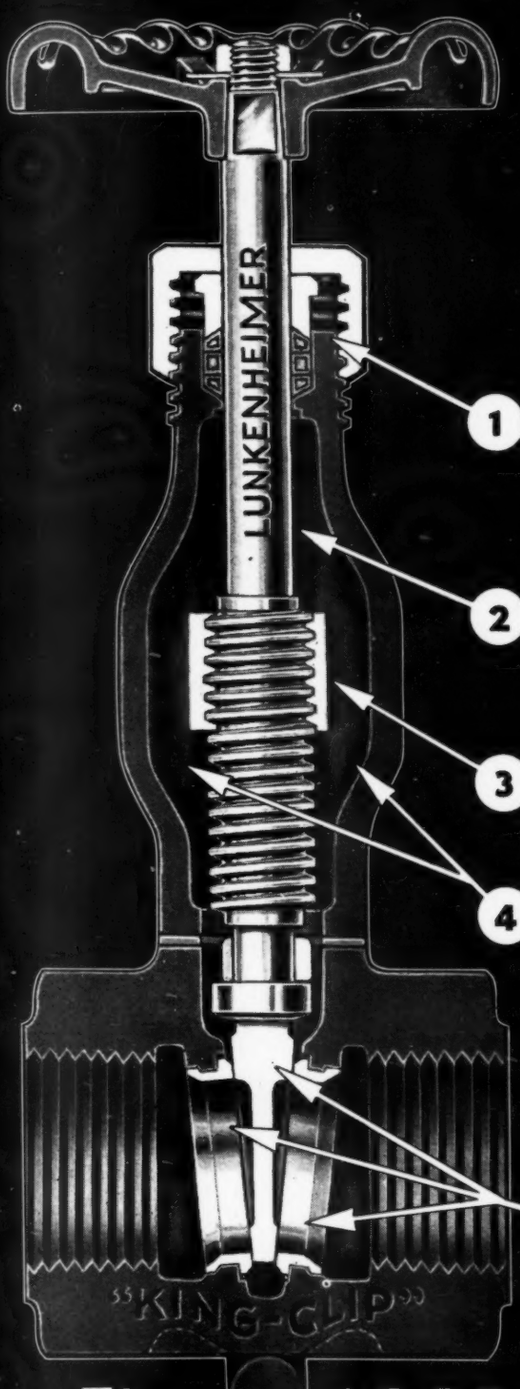


Fig. 1640

LUNKENHEIMER

Fig. 1640 "KING-CLIP"

(The King of Clip Valves)

1 Stuffing Box
Extra strong construction—hexagon head gland.

2 Bronze Stem
Perfectly aligned—repacking seat above stem threads.

3 Bronze Bonnet Bushing—
Cast in. Non-corrodible contact for stem.

4 Drain Channels
Large and unobstructed—ample size to drain bonnet. Will not clog.

5 Bronze Disc and Rolled in Bronze Seat Rings
Bronze to bronze contacts prevent corrosion.

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Derrick-floor control for this drive has not been shown on the accompanying drawings, but this is a comparatively simple hook-up. A shaft is supported between and slightly higher than the engines. On this is mounted a series of sprockets each connected to the throttle of one of the engines by roller chain. One sprocket is used to connect the shaft and the throttle on the derrick floor by roller chain. When normal drilling operations are in progress, the derrick throttle controls only the speed of the engine driving the rotary table. The pump engines are controlled at the engines. When removing or replacing drill pipe the throttle on the derrick floor will control the speed of all engines being used. This control will be through one throttle only. To facilitate carrying equal loads on engines that are compounded, pyrometers may be installed having dials on the derrick floor so exhaust temperatures may be readily observed by the driller. If any one engine shows a higher or lower exhaust temperature than the other engines with which it is compounded, the throttle can be adjusted to cause the engine to again carry its proportionate share of the load. Each engine should have a tachometer and have automatic safety stops to guard against high water temperature or low lubricating oil pressure. In this type of rig, one engine out of service temporarily would not interrupt normal drilling and hoisting operations using the remaining three engines. Having surplus power available, it is possible at any time to shut-down an engine for minor adjustments and repairs without reducing the normal speed of drilling operations. This is because three engines at maximum load will produce slightly more power than the four engines when operating at their rated load.

A sturdy sub-base should be used, as the entire assembly will be moved as a unit. This will eliminate distortion and prevent the shafts becoming out-of-line. Further, a sufficient number of outboard bearings should be used to insure proper shaft alignment. There is sufficient space between the engines to service them when necessary. All belts and sheaves should be protected by guards, not shown on the drawings, to avoid hiding the pulley arrangement. It would be advisable to cover the sub-base using metal flooring to facilitate safe access to the engines and the drive for adjustments. No building is required over this drive if the belts are covered as the engines have hood and side covers.

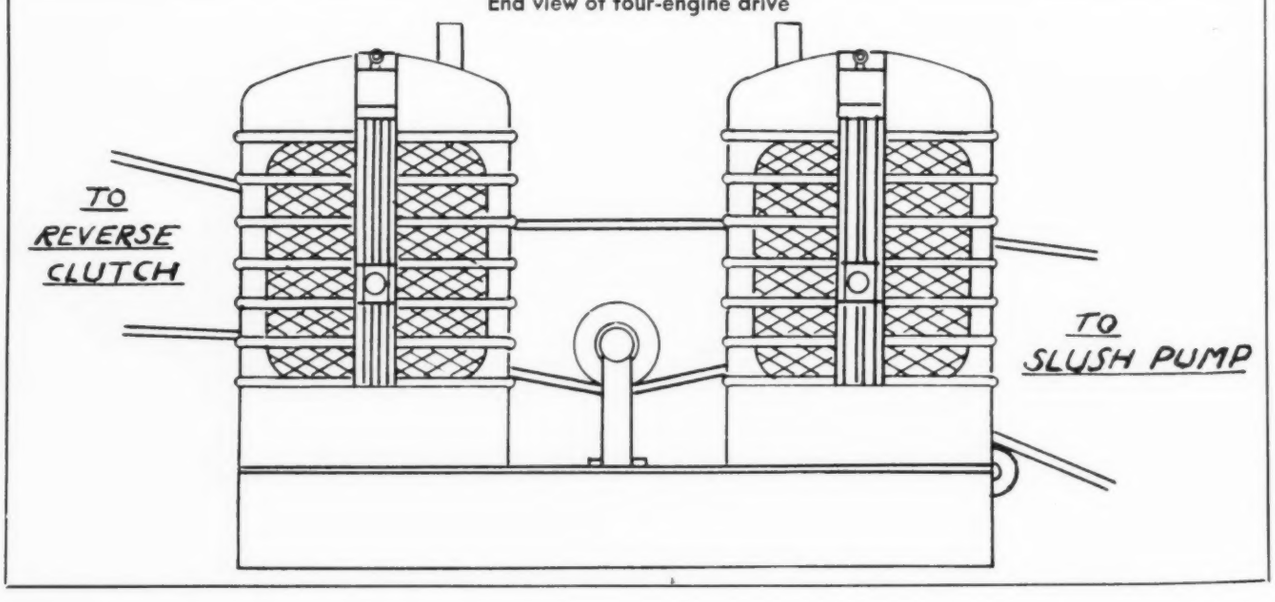
The cost per horsepower of this rig would be less than the horsepower cost of the conventional two-engine rig drive. The additional power and flexibility of this type of drive can be utilized at no additional cost over the other type of rig drive. The engines recommended for this drive are equipped with hydraulic governors, which give extremely close regulation, a desirable feature when two or more engines are compounded. This drive when powered by the four engines should easily drill to depths of 6000 ft. using 6⅝-in. drill pipe.

Undoubtedly, some may believe that past experience with so-called high-speed engines makes the performance of this proposed rig somewhat doubtful. In this connection it is important to keep in mind that high piston speeds, high brake mean effective pressures due to overloaded conditions, and vibration due to insufficient balancing effects within the engine, have been more responsible for engine failure than high rotative speeds. When piston speeds are conservative, and when there is sufficient engine capacity available to operate at brake mean effective pressures of between 70 and 75 lb., and when vibration has been eliminated by correctly balancing the otherwise unbalanced inertia forces within the engine, the life and maintenance costs will not vary from those of the conventional type of slower speed engine. This fact is borne out when it is realized that many large steam turbines producing tens of thousands of horsepower per unit operate at rotative speeds of 1800 r.p.m. This is accomplished by accurately balancing all the rotating parts.

It is believed that the increased flexibility, increased ease of rigging-up and moving from one location to another, and the high maximum horsepower output available make this drive extremely desirable for drilling to depths of 3000 to 6000 ft. The fact that an adequate supply of power is available at all times for driving the slush pump will eliminate the necessity of so frequently changing liners in the pump in an effort to ease the load on the engine, which is a common occurrence on two-engine driven rigs.

Engine nos. 2 and 4 will rotate clockwise and engine nos. 1 and 3 will rotate counter-clockwise when viewed from the radiator end. Exhaust manifolds, battery-charging generators, and starters will be mounted on the right side of engines 1 and 4 and on the left side of engines 2 and 3, all when viewed from the radiator end. All other accessories will be mounted on the opposite side of each engine.

End view of four-engine drive



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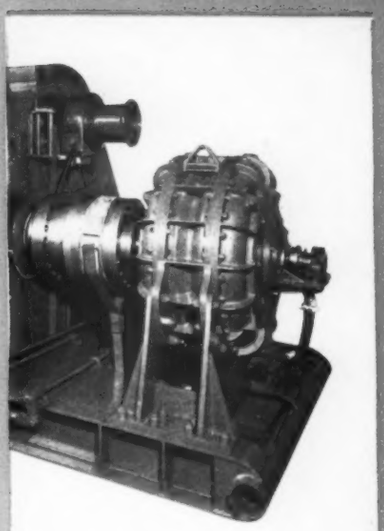
EMSCO "ED" SERIES DRAWWORKS

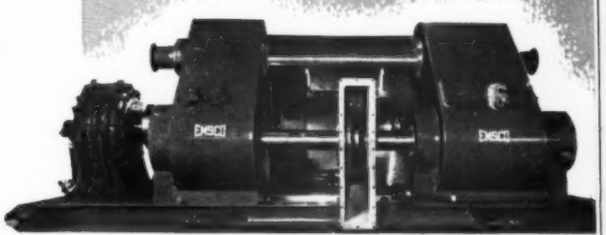
Greatly increased drilling depths have called for a drawworks of unusual size and strength—a demand that has been met with the new Emsco "ED" Series Drawworks.

Built for drilling to any depth contemplated in the immediate future, the "ED" Drawworks has 60-inch forged-steel brake rims, and with Emsco's multiple leverage CB brake, positive safety is insured when handling the longest strings of pipe. Double-strand chain drives, pressure-spray lubricated, guarantee long service life. An extra-wide drum provides ample wire line capacity. All controls are conveniently centralized at the driller's position with no point overlooked to make for safe and convenient operation.

The "ED" Drawworks may be furnished for either 3-speed or 4-speed operation. Conversion from one speed to another may be made quickly and economically when desired. Continental representatives will gladly explain the many other features of this outstanding drawworks. Ask for complete information today.



A disengaging flexible coupling operated by the driller, cuts in or disengages as required to give instant operation of the hydromatic brake.



Rear view of drawworks showing built-in snout for oil bath engine drive guard —a part of the drawworks pressure-spray lubrication system.

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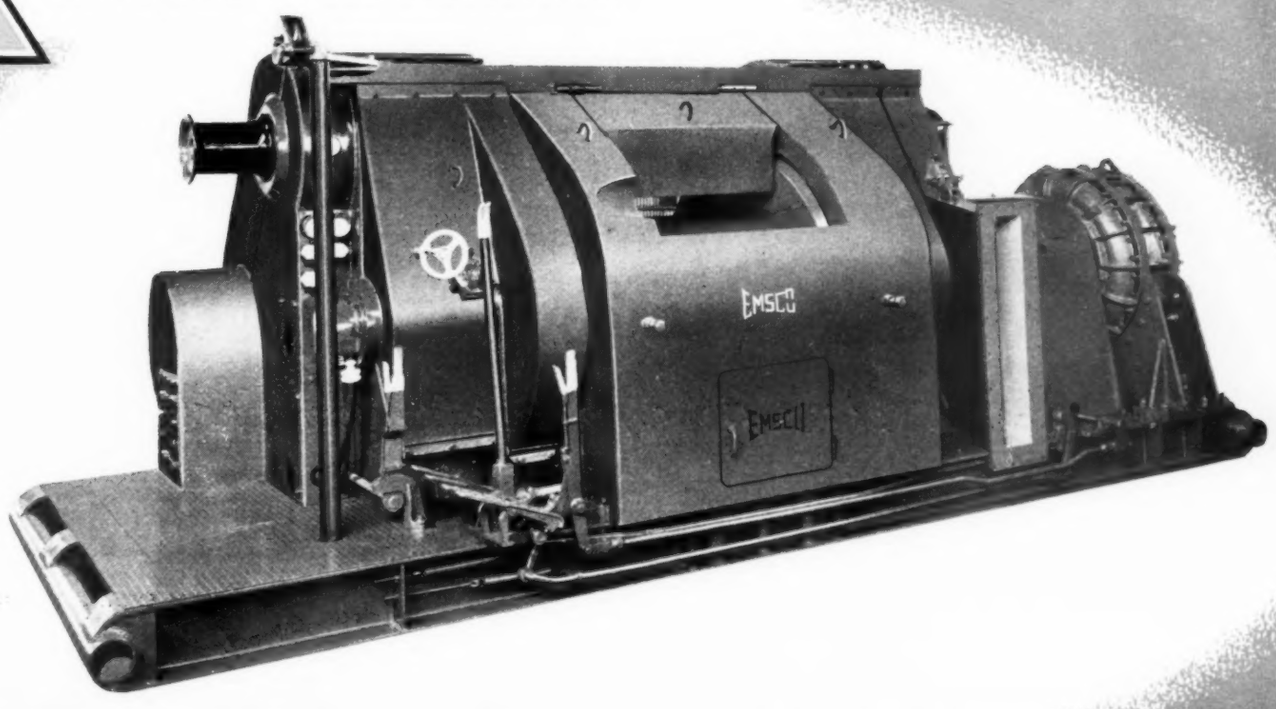
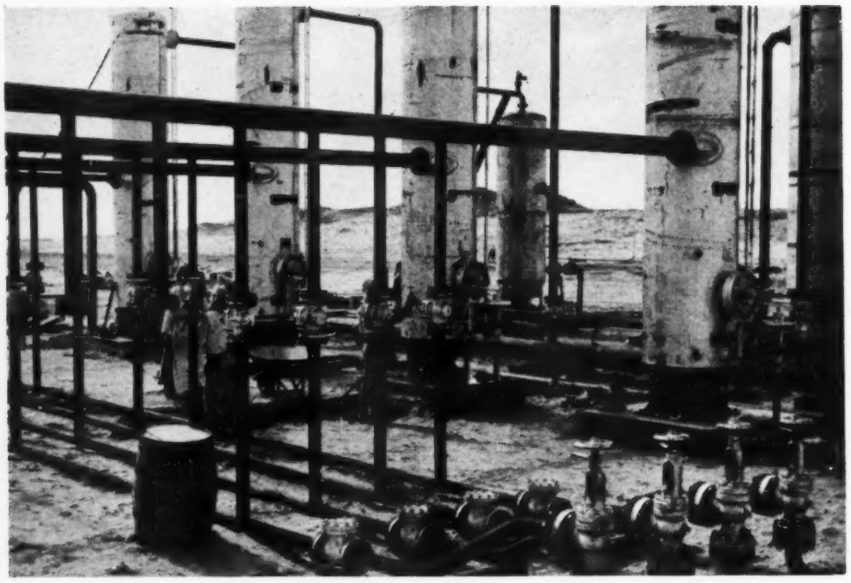




Manifold piping being assembled—adjustable flow beans are shown in foreground

New installation in Saudi Arabia includes equipment to measure all gas produced and to test each of 30 wells individually

Battery of Oil-Gas Separators Provides Flexible Operation for Test Purposes

AN installation that embodies all the desired features for efficient oil and gas separation has recently been completed in the Dammam field, Saudi Arabia, by the California Arabian Standard Oil Company. The accompanying flow diagram indicates the geometric pattern in accordance with which the equipment is installed in two identical arrangements. Salient features of the installation are eight 3 ft. by 16 ft. 500-lb. separators, two 3 ft. 6 in. by 13 ft. 6 in. 150-lb. separators, and two 5 ft. by 16 ft. 6 in. 150-lb. separators. Fifteen 4-in. lead lines from the wells enter the manifold at one end; fifteen 3-in. lead lines enter the opposite end of the manifold.

Each of the 30 lead lines enters the manifold successively through a 3-in. adjustable flow bean, a 3-in. check valve, and a 3-in. insulating flange. The latter is installed to guard against corrosion that might result from electrolysis caused by stray currents entering through the lines from the wells.

The extensive manifolding permitting any one well to be diverted into any of the high-pressure separators requires 150 plug-type 3-in. valves. Valves are flanged to permit their easy removal from the line for replacement or repair but the manifold piping is fabricated, using welding fittings. Lines to the traps are 6 in. and are approximately 11 ft. overhead, providing ample clearance and permitting the valves to be situated on the vertical risers at about shoulder height to facilitate easy manipulation.

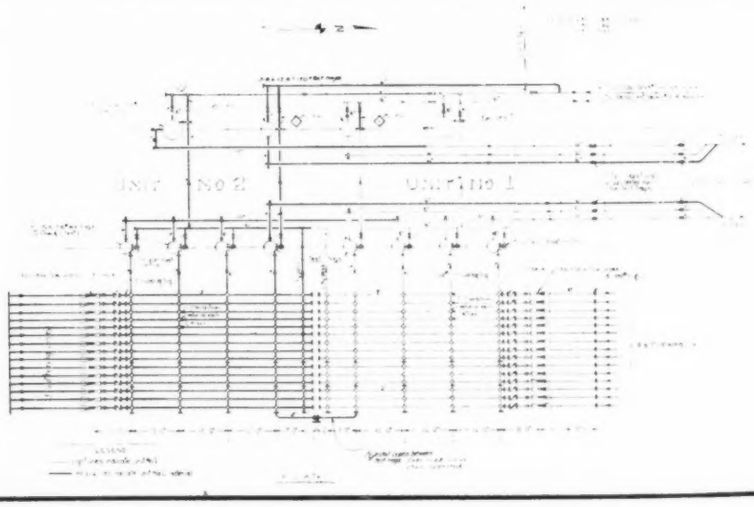
The two center high-pressure traps are used as test traps for gauging the potential of individual wells. Two wells may thus be tested simultaneously. Well testing also requires the use of the two smaller low-pressure traps for secondary separation.

Gas separated from the oil in both high and low stages is piped to two 10-in. stacks, one for each stage. One 10-in. and two 6-in. lines leading to each of these stacks serve as meter runs so that all the gas is metered. Gas produced from the wells being tested is, of course, measured separately.

Storage facilities for the oil produced include four 30 ft. by 16 ft., 2000-bbl. tanks and three 102 ft. by 40½ ft., 59,000-bbl. tanks, a total capacity of 185,000 bbl. Two of the small tanks are used to gauge wells being tested.

The wells served by this installation each produce from 500 to 3500 bbl. daily. Flowing pressure at the wellhead varies from 775 to 850 lb. per sq. in. Flow beans are installed at the wellhead in each instance but the beans at the trap-end of the lead lines are used normally so that the flow at high pressure will result in less pressure drop caused by friction. Pressure just prior to reduction in the trap bean is from 750 to 825 lb. per sq. in. Normal pressure maintained on the high-pressure separators is 250 lb.; on the low-pressure traps, 50 lb.

Flow diagram indicating the geometric pattern of the installation



Equipment used in photographing corrosion

By
BILL DAVIS

Mechanical Engineer,
American Liberty Pipe
Line Company

Photographing Pipe-Line Corrosion Important Part of Survey Method

A permanent record of corrosion is provided and a closer study of pitting on underside of pipe made possible

RECENTLY the American Liberty Pipe Line Company made a corrosion survey of a 30-mile section of its 183-mile, 8-in. main line between Kilgore and Houston, Texas, with a view to installing cathodic protection.

The desire of officials was to obtain a permanent record of the type and extent of corrosion at "hot-spots" indicated by survey instruments. Several means were discussed, such as plaster casts, sheet lead, and photographs. The latter course was decided upon.

It was anticipated that a large part of the corrosion would occur on the lower half of the pipe—the area most difficult to photograph. Actual work on the main line revealed that this was the prevalent condition, as nearly all corrosion was concentrated on the lower side of the pipe, there being only minor etching on the upper side. Incidentally, only one photograph was taken of the upper side of the pipe during the entire survey.

The limited space in which the cameraman had to work presented a definite problem. The depth of the 8-in. line varied from 24 to 36 in. Preliminary plans provided for the inspection holes to average 10 ft. in length, about 4 ft. in width, and a clearance of 1 ft. under the pipe. This last specification precluded any possibility of getting a camera under the pipe. The additional time, labor, and expense of deepening the test hole to, say, 36 in. below pipe depth, together with the limited area and doubtful focusing even with a double extension bellows, ruled this close-range method out entirely.

This left only the possibility of using a mirror under the pipe, mounting the camera over the top of the test hole, and recording the reflected image rather than the actual pipe surface. This was the method used throughout the survey. The procedure was tested on a buried section of pipe before start-

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was born in Fort Worth, Texas, in 1915—Graduated from Texas Technological College, Lubbock, Texas, in 1937 with a degree in mechanical engineering—Became associated with oil industry by joining staff of E. F. Moran Drilling Company—Later was employed by the Continental Oil Company at Hobbs, New Mexico—Early part of 1938 he joined the engineering staff of the American Liberty Pipe Line Company as mechanical engineer.

Survey party digging test hole in Spring Creek River bed

ing the survey and was found satisfactory.

In selecting the photographic equipment the requirements of utility, weight, and portability were foremost, and after due consideration the following equipment was used:

(1) A 3¼-in. by 4¼-in. Voightlander Avis camera having Scopar F. 4.5 lens, equipped with ground-glass focusing back and nine cut-film holders.
(2) A 180-deg. swivel-head to use between the camera and tripod to point the camera downward.
(3) A 48-in. telescoping metal tripod.
(4) Mendlesohn Model C speed-gun timer having a special 6-ft. extension cord made from rubber-covered wire and a male and female socket to match the standard equipment.
(5) A small pencil-type flashlight to aid in accurate focusing.
(6) A good grade mirror, 12 in. by 18 in., having no blemishes, scratches, waves, or visible distortion.
(7) A supply of No. 2 Wabash Super Flash bulbs.
(8) A supply of 3¼-in. by 4¼-in. Super Sensitive Panchromatic cut film.

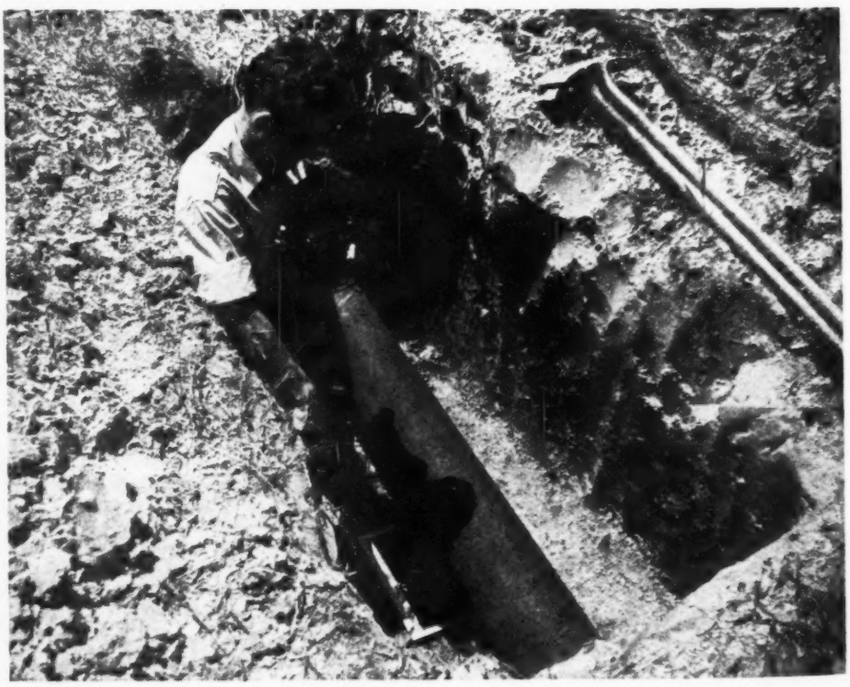
This material, except for the last two items, was packed in an ordinary canvas overnight bag for easy portability. The bag was carried by a member of the crew when the station wagon was unable to follow the survey party on the right-of-way. Only enough flash bulbs were carried in the bag for a half day of shooting, the rest being packed in the station wagon.

The taking of the photographs at each test hole was preceded by diligent cleaning of the pipe. First, the dirt was scraped-off the surface of the pipe using shovels. When all the loose material had been removed, two members of the crew, utilizing hammers, and scrapers made from discarded auto-spring leaves, went over the pipe inch by inch, removing all scale from the surface and pits. Then the entire surface was wire-brushed until it shone like a polished rod. All moisture was wiped from the cleaned surface and readings were taken by a pit gauge.

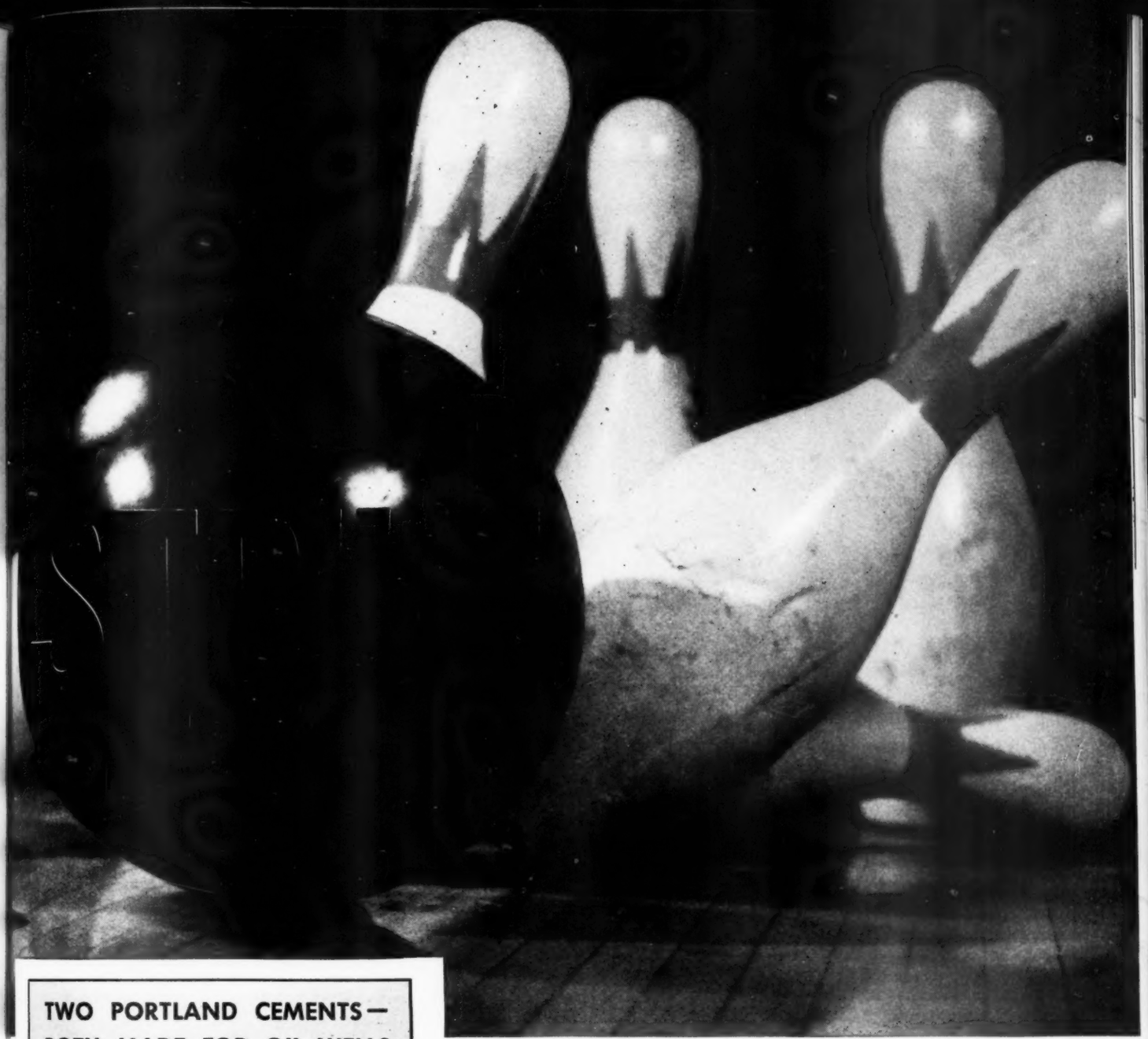
As soon as a section had been selected and prepared for photographing, the equipment was set up. The tripod was placed at one side of the pipe having two legs in the hole, and the third "short-legged" into the loose dirt at the top of the hole or into the side wall, depending on how deep the pipe was at that point. The swivel head and camera were placed on the tripod and the camera pointed straight down, opposite the section to be photographed.

The mirror was the most troublesome part of the equipment. It had to be cleaned after each shot and brushed clear after every adjustment for focus. Placing it under the pipe was the last step in setting up. It was an easy matter to get the right tilt by "cribbing up" with dirt or sticks until the correct angle of reflection into the camera was obtained. An assistant held the beam of a small flashlight on the pipe to obtain a sharper image on the ground-glass.

The total distance focused was from the camera lens to the mirror plus the distance from the mirror to the pipe. Often this was as much as 6 ft. As a result it became necessary to obtain the outline of the circle cast by the flashlight in as sharp a focus as pos-



Focusing on the image reflected in the mirror placed beneath the pipe



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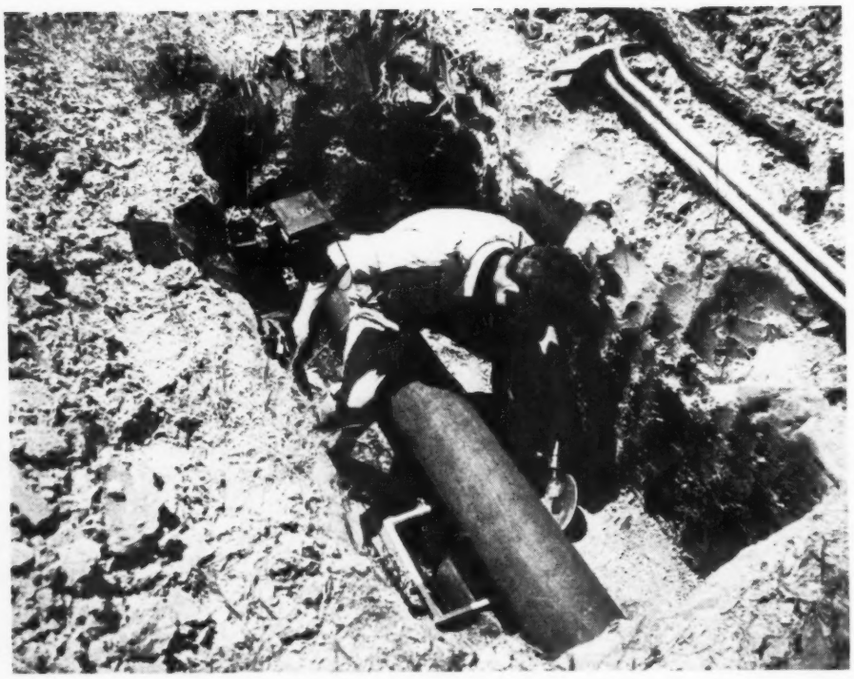


Placing the reflector in position for an exposure

sible. Later, when the exposure was made at F. 32 under these conditions, all discrepancies in focusing were eliminated.

As soon as the camera had been accurately focused, the ground-glass was removed and the cut-film inserted. At this time the Mendlesohn speed-gun timer was placed on the front of the camera and carefully adjusted. The extension was attached to the timer so that the reflector might be placed below the pipe instead of being fastened to the side of the camera where it would be used normally. This extension permitted considerable flexibility in placing the light source where it would be the most effective.

A final check was made before each exposure, to see that everything was in order. All electric plugs were inspected for good contact, shutter adjustment and timer assembly were checked, and the film slide was removed for the first time. This last-minute examination undoubtedly saved several shots from being ruined. The most frequently overlooked detail was forgetting to stop-down the lens to the proper opening after using it wide open for focusing. Another point that was easily overlooked was cocking the shutter. With this type of speed-gun it was possible to flash the bulb even though the shutter was not cocked.

Two exposures were made at each set-up, the only change being a different position of the light source. In both cases the reflector was held on the far side of the pipe and in such a position that the light could not shine directly into the camera. The first exposure was made with the reflector to the right of the camera, and the second with the reflector to the left of the camera.

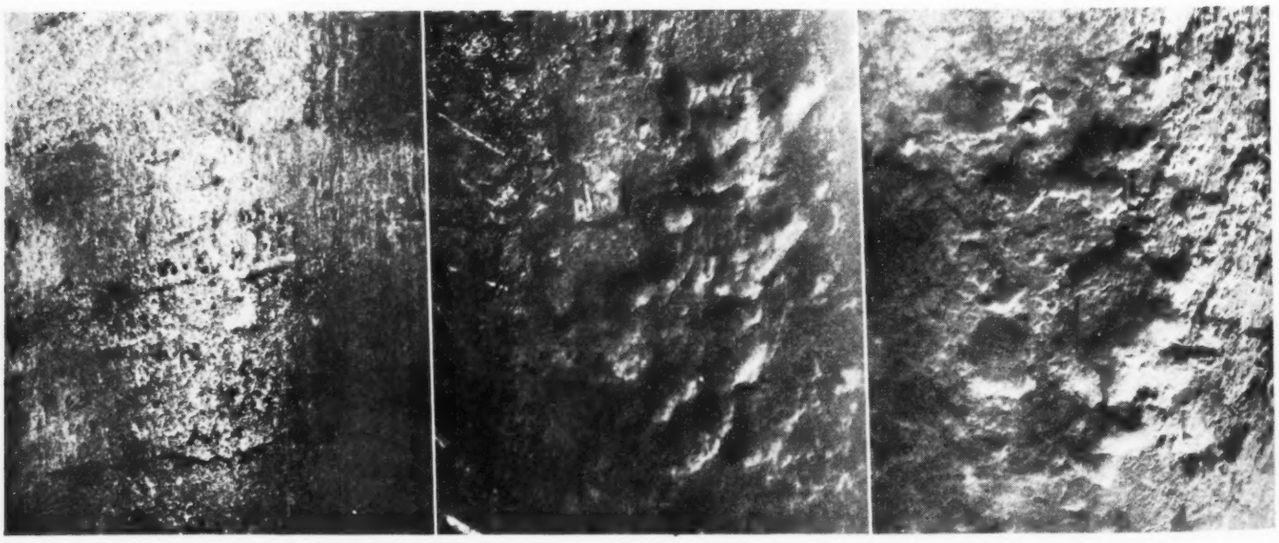
As a high-speed film was used, the camera was usually set at F.22 or F.32 and 1/200 second. This insured maximum detail and stopped any motion caused by jarring the tripod.

In finishing the pictures, only the part of the negative that showed the worst pitting was used. An enlargement on bromide paper was made of the best negative from each group. In making the enlargement the image of the pipe was brought as close as possible to actual size to show the pits in their true magnitude.

As will be noted in the accompanying illustrations the pits if viewed from one angle appear to be in relief, or raised, but if the picture is turned 90 deg. or more they show as true pits. This is caused by side-lighting and is a phenomenon not uncommon in photography.

This type of picture forms a permanent record along with other information obtained during the survey and gives a more definite idea of the condition of the line than would a word description.

Examples of pictures taken, showing corrosion ranging from light etching to deep pitting
(Pictures are two-thirds actual size)



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Alloy Steels

Solvent Refining of Petroleum

In one method two solvents insoluble in each other are used to increase selectivity of the solvent-extraction process

By B. KWAL

IN recent years petroleum technologists have been searching for a new method to increase the viscosity index of lubricating oils. These investigations have disclosed that the solvent extraction process is capable of producing high-viscosity-index lubricating oils from mixed-base and naphthenic-base stocks. From the standpoint of selectivity, the ideal solvent will separate completely the undesirable fraction from the desirable fraction. To fulfill these conditions the solvent must show a high solvent power for the undesirable fraction and yet dissolve none of the desired fraction at the temperature of extraction. Most available solvents fail to attain this ideal requirement. Either, though being miscible in all proportions with the undesirable constituents, they possess too high a solubility for the desirable components or, though satisfactorily low in solvent power for the desirable components, they do not possess complete miscibility in all proportions with the undesirables.

It should be noted that the extraction process must be carried out in a manner that will assure the fractionation being executed as sharply as possible. In other words, the desirable fraction should show no content of the undesirable compounds and vice versa. The first type of the abovementioned solvents will give good raffinates of high-viscosity index, but due to their excessive solubility in the extract phase, the loss of good components will prove expensive. Conversely, the second type of solvent mentioned does not economically result in raffinates of favorable viscosity index because of an insufficient difference in partition ratios of the desirable fractions between raffinate and extract phases. This indicates that the extractive fractionation of oils depends largely upon the solubility and flexibility of solvent agents.

Two general types of solvents are used in the solvent refining processes. Either a single solvent is used that dissolves the high- or the low-index material or two solvents are used, one of which dissolves the high-index oil and the other the low-index oil. Of course the separation between these fractions is never perfect, and the effectiveness of the solvents differs in this respect.

Before going into the details of the solvent refining processes, it will be well to consider the components of lubricating stocks. According to one investigator, lubricating oils contain the following constituents: (1) asphaltenes, (2) carbogenes, containing higher molecular unsaturated compounds related to aromatic hydrocarbons, which easily cause deposition of carbon and mud, (3) naphthenes having low-viscosity index and low flash point, (4) parathenes (naphthenic rings having paraffinic side chains) containing hydrocarbons of high quality, and (5) paraffinic hydrocarbons.

A solvent refining process to be favorable must be conducted in a manner that will result in the removal of the undesired hydrocarbons from the oil. Simple equipment for this process is a battery of vertical columns wherein the raw oil and the solvent flow countercurrently. The process of selective refining is governed by the law of distribution. The oil, therefore, must be submitted several times to solvent refining to remove the maximum amount of undesirable compounds. The first practical solvent of the two-phase type was developed by Edeleanu, the basis now of a very important process. In this refining process two phases are formed, the raffinate and extract. The first contains paraffinic and naphthenic hydrocarbons; the second contains only aromatic and unsaturated hydrocarbons. As liquid sulphur dioxide will dissolve a considerable amount of paraffinic and naphthenic hydrocarbons at a temperature of 14°F., the extraction must be carried out at a lower temperature (—60°F.). The extract in this process of refining oils can be considered as the main product because it is used as an anti-knock material in gasolines and as a lacquer solvent.

The Edeleanu process employing liquid sulphur dioxide is also used to improve Diesel fuels. Thus higher octane numbers, Diesel indexes, lower carbon residues, and lower sulphur contents are obtained in the sulphur-dioxide raffinates produced from both straight-run and cracked gas oils. According to the investigations of Steffen and Sagebarth, the Diesel index number of cracked gas oil can be increased from 40 to 81, when submitted to an extraction using sulphur dioxide. Due to the selective solvent power of sulphur dioxide all low-boiling fractions can be satisfactorily separated into their components. To increase the degree of the solvent power of liquid sulphur dioxide, benzol is added in varying quantities.

The benzol-sulphur dioxide process has an extraordinary solution power for unsaturated, aromatic, resinous, sulphur-containing, and otherwise non-paraffinic compounds. Using this combination process, lubricating oils of zero pour point and 90 to 100 viscosity index possessing a corresponding improvement in carbon residue, stabil-

THE AUTHOR

B. Kwal was born in Austria in 1895—Received a degree in chemistry from University of Vienna—In 1918 he established his headquarters at Lwow, Poland, where he still resides, his work being concerned principally with colloidal chemistry and the manufacture and polymerization of resin oils—The last several years the mineral oil industry has claimed much of his attention—Recently he devised a process for the manufacture of artificial resin.

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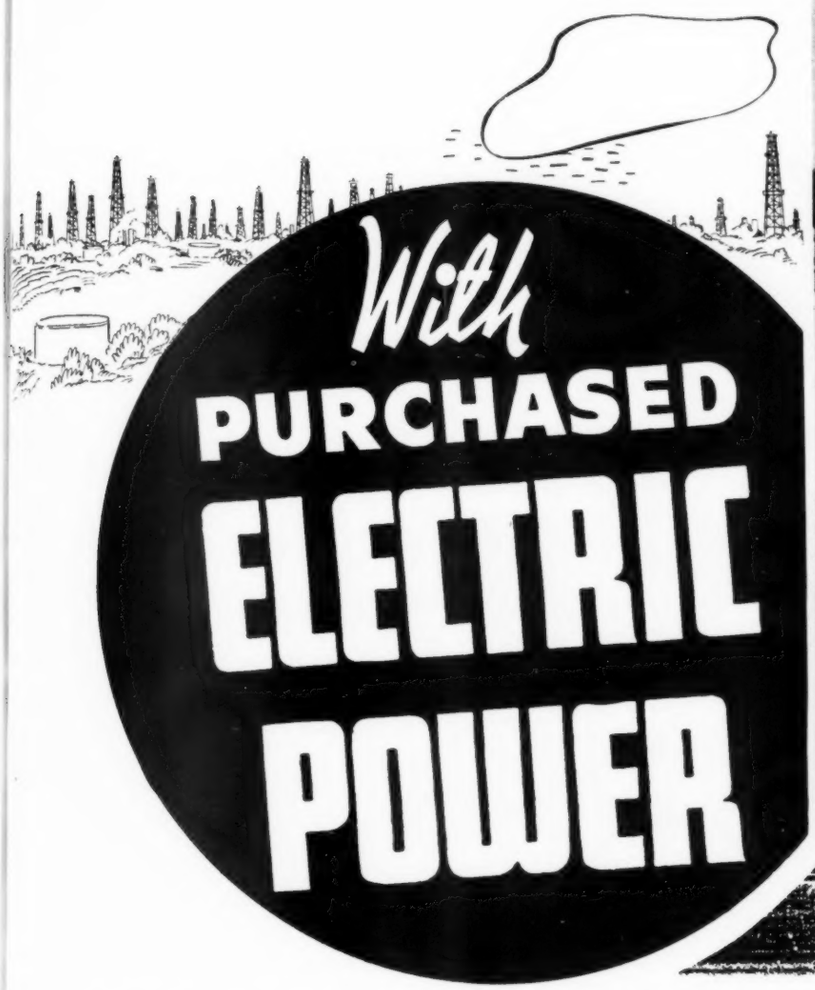

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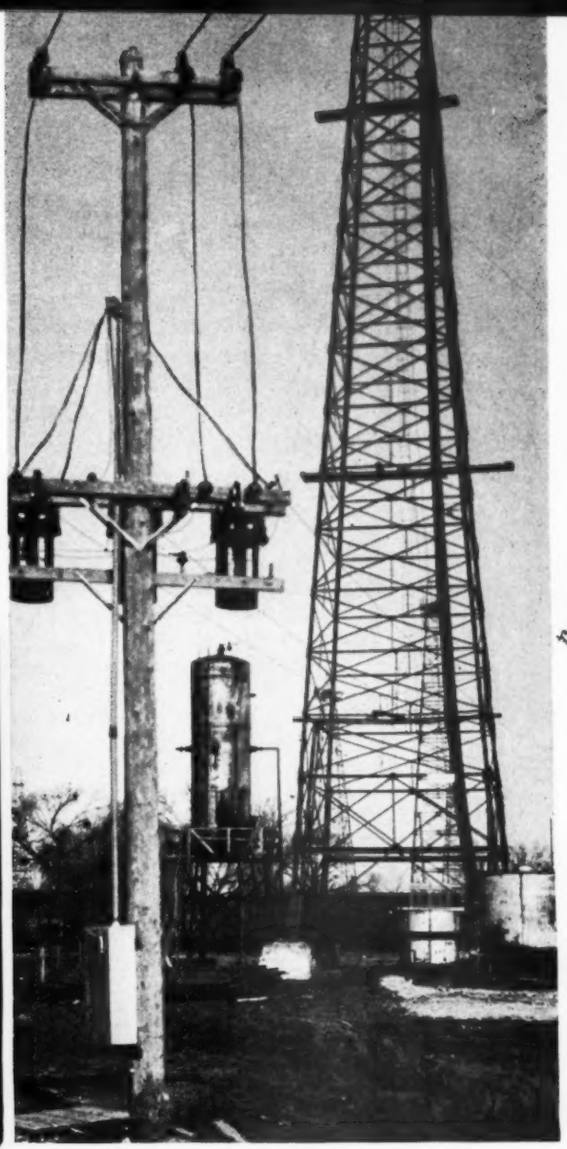

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ity against oxidation, and other important characteristics may be obtained from mixed base stocks.

An interesting refining method is that of phenol extraction. The treatment of phenol was first studied by Kuczyński in 1922[1]. Fussteig elaborated on this using an analytical method employing phenol in 1929[2]. This process is known as the phenol extraction process patented by the M. W. Kellogg Company. Fig. 1 is a flow diagram of this process.

In this process, the charging stock is countercurrently contacted with anhydrous phenol at temperatures within the range of 110 to 200°F., depending on the character of the charging stock. High carbon residue constituents, color bodies, and naphthenic compounds in the charge are dissolved in the solvent, forming the extract phase, and leaving the more paraffinic constituents, in which is dissolved a small amount of solvent, to form the raffinate phase. These phases are separated by virtue of the difference in specific gravity. Solvent is recovered from both phases by distillation.

Another interesting method is the de-asphalting and de-resining of crude residues by means of propane. Between 38 and 60°C. the asphaltic compounds are not soluble in the propane, but all other hydrocarbons are very soluble at these temperatures. It is possible, therefore, to precipitate a high gravity, high melting point, and low penetration asphalt by diluting crude residuum with four parts by volume of liquid propane and settling at a temperature of 46°C.

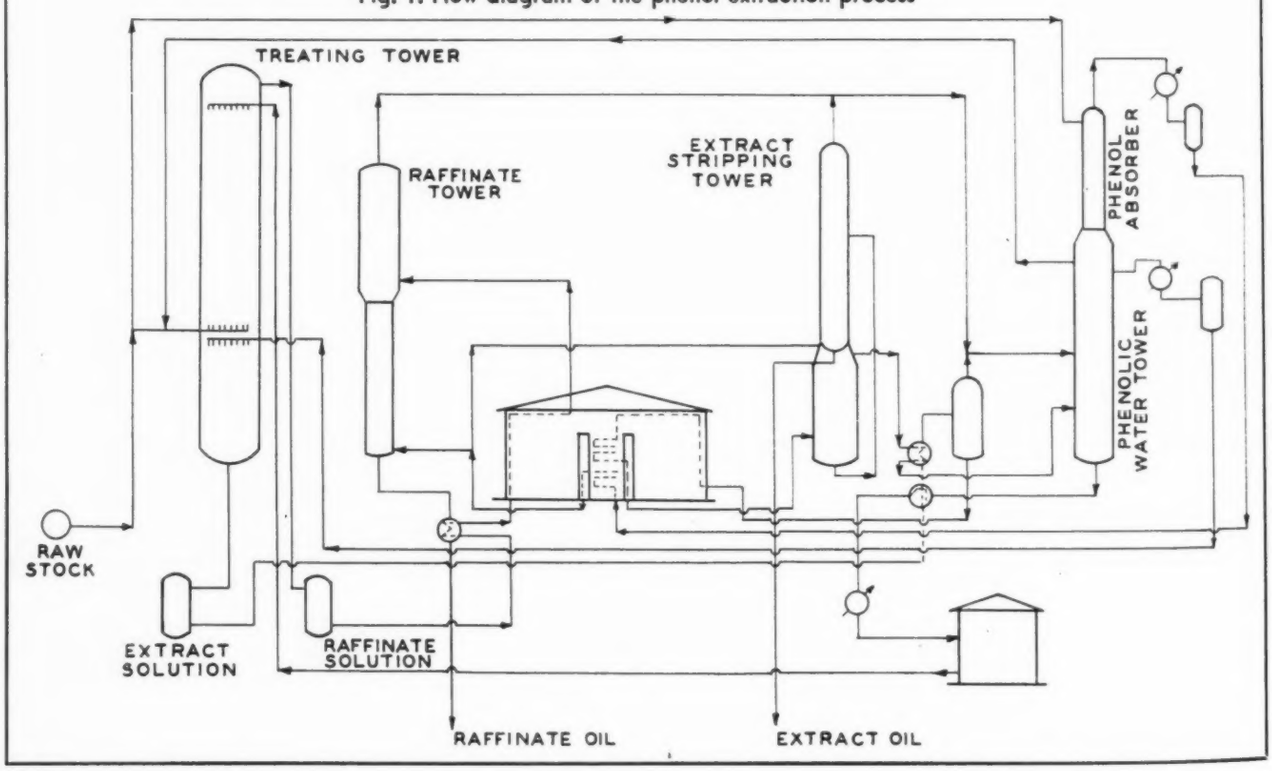
The nitrobenzene extraction process commercially operated by the Atlantic Refining Company, according to many investigators, has great value in the refining of high-grade lubricating oils. Ferris and Houghton[3] have shown that when comparing nitrobenzene to phenol and liquid sulphur dioxide, the first will result in a better solvent than the latter because it will yield a lubricating oil of a high-viscosity index without great losses. The extraction by means of nitrobenzene is carried out in a manner that results in highly paraffinic compounds being insoluble in it, the asphaltic and highly naphthenic compounds being very soluble, and the compounds of intermediate character having solubility between the two extremes. When an oil is mixed, therefore, with nitrobenzene, the least desirable components are most readily dissolved and removed. By varying the degree of treatment, the quality of the material remaining undissolved can be controlled over a wide range.

Nitrobenzene is very sensitive in its solvent action on asphaltic, naphthenic, and aromatic compounds. As a result, the nitrobenzene process requires a low solvent oil ratio to produce a given yield of a given quality oil. These ratios vary from 0.5 volumes to 2 volumes of solvent per volume of oil. This solvent has a high specific gravity and a low viscosity at the temperature employed for extraction. As a result, mixing and settling in the extractor system are rapid and complete. The operating process is in two steps. The first step consists of contacting the charge oil with nitrobenzene in a multi-stage countercurrent extractor composed of a series of mixers and settlers; the second step consists in recovering the nitrobenzene from the raffinate and extract solutions.

Other aromatic amines have been proposed for the refining of oils. Ehlers[4] has outlined a method for removing tarry, resinous, and similar compounds from lubricating oils by agitating them for one hour with 30-70 percent of aniline, toluidine, or xilidine, and then settling and separating the two layers. A similar method has been patented by Chappel and Ziser, proposing the removal of reactive unsaturated compounds from lubricating oils by heating them with aniline and then cooling to separate the solution into two layers, the aniline and the extracted

[1] *Petroleum*, 1939.
[2] *Les Matieres grasses*, 1930.
[3] *Proceedings of the World Petroleum Congress*, Vol. II, p. 370. World Petroleum Congress, London, England, 1934.
[4] B. P. 184,991.

Fig. 1. Flow diagram of the phenol extraction process



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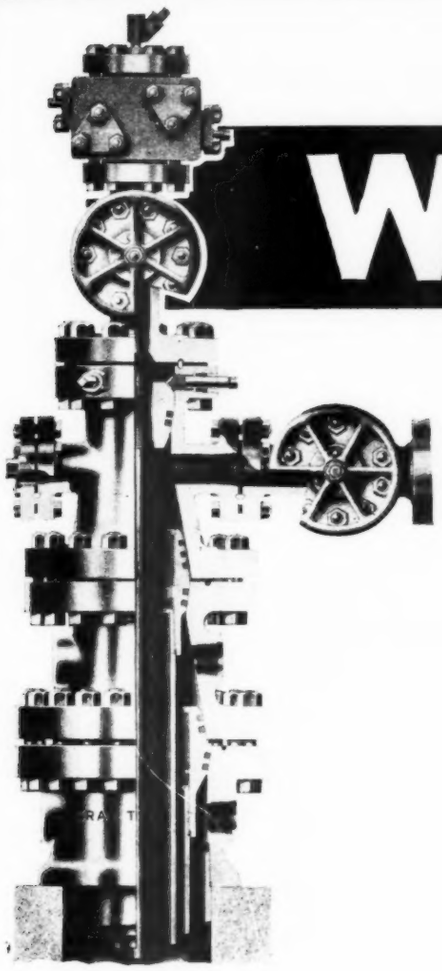

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material remaining at the bottom. According to these investigators the best results give a lubricating oil having an initial boiling point of about 400°F.

The Texas Company has patented the process for refining oils by means of furfural, this compound being the aldehyde of pyromucic acid. This solvent is produced by distillation of bran with diluted sulphuric acid and therefore its cost is relatively low. Furfural is employed normally in the extraction system at temperatures from 150-200°F., at which temperatures virtually every lubricating oil can be readily processed. Prosumentik and Rybak[5] state that the refining of oils by means of furfural presents the most economical extraction process, because it permits removal of 90 percent naphthenic acids, thus eliminating further treatment of oils with caustic soda.

The treatment of oils with furfural is executed countercurrently in special towers filled with Raschig-rings, the solvent agent being charged to the tops of the towers at a temperature of 200-260°F. and the oil entering the bottoms of the towers. Such a plant comprises the following units:

(1) Vertical counterflow extraction tower including suitable exchange and cooling equipment to provide means for charging solvent and oil at controlled, predetermined charge rates and temperatures.

[5] *Aserbaidzanskoe napthenoe chosjajstwo*, No. 9, 1935.

(2) Surge capacity in the treating tower itself for storage of raffinate and extract solutions prior to charging these solutions to respective solvent recovery equipment.

(3) Solvent-from-extract recovery unit, including open steam stripper for removal of final traces of furfural from extract.

(4) Solvent-from-raffinate recovery unit, including steam stripper.

(5) Solvent-from-water recovery system, including settler and two fractionating columns.

Refined oil solution containing only a small percentage of furfural flows from the treating tower by gravity through heat exchangers to an atmospheric flash tower. The extract solution, containing the major portion of furfural, is pumped through heat exchangers to an atmospheric flash tower, where approximately 30 percent of the furfural contained in the extract mix is vaporized.

All organic solvent agents discussed so far contain ring structures. Organic solvents having straight chains are also used. Chlorex is an example of this type. This solvent is produced from ethylene. When ethylene is submitted to a chlorination process with chlorine water, bis-β-chlorethyl-ether will be obtained, this being called "chlorex." Aside from the desirable property of high selectivity, this solvent is particularly well adapted to plant-scale usage. Its boiling point is well below the vaporization temperature of motor oils, and its high specific gravity permits rapid separation of the two phases formed with the oils.

According to Bahlke, Brown, and Divoky[6] chlorex is a very good solvent agent as it is able to raffinate all distillates from the lightest motor oils to the heaviest cylinder stocks economically. Fig. 2 is a flow diagram of this process.

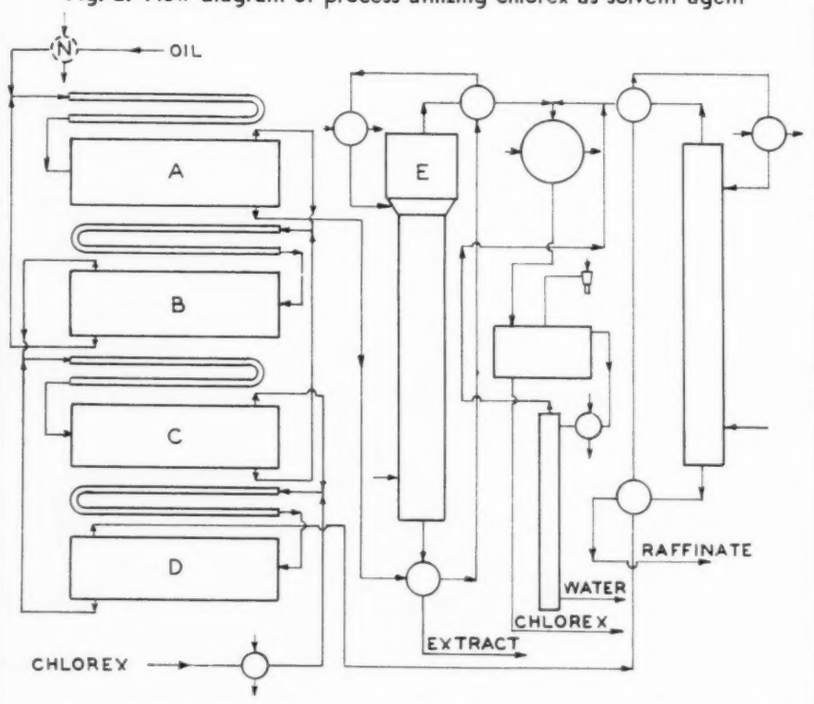
In the process the oil is pumped through the heat exchanger *N* into the first-stage pipe mixer, in which it is mixed with the extract solution from the second stage. This mixture settles in the first-stage settling tank *A*. The extract solution from *A* is pumped to the extract distillation unit *E* for continuous recovery of the solvent, and the raffinate solution from the first stage flows under first-stage pressure and is mixed in the second-stage pipe-mixer with extract solution from the third stage.

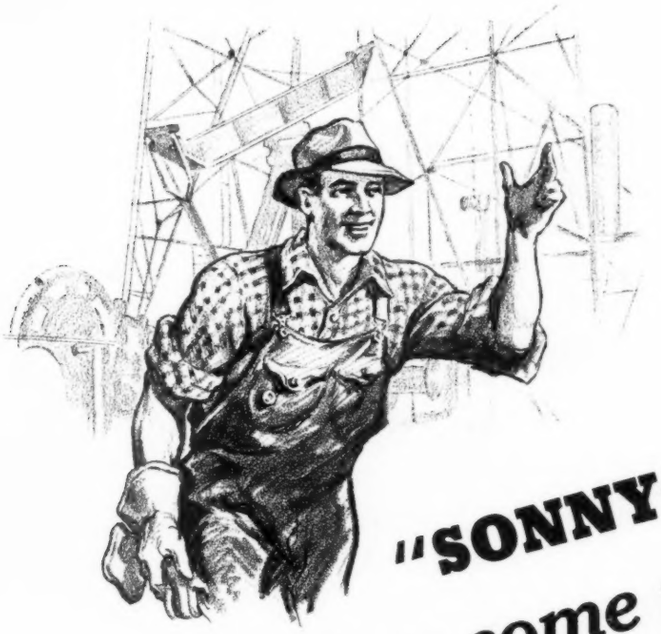
This mixture settles in the second-stage settling tank *B*. Raffinate solution from the second-stage settler is mixed with extract solution from the fourth stage in the fourth-stage pipe mixers. This mixture settles in the third-stage settling tank *C*. The raffinate solution from the third-stage settling tank is now mixed with fresh chlorex in the fourth-stage pipe mixer, this mixture settling then in the fourth-stage settling tank *D*. The final raffinate solution, from the fourth-stage, is pumped under automatic control to the raffinate-solution distillation unit for continuous recovery of the solvent.

An interesting improvement of the extraction processes is in the use of two solvents, insoluble in each other but one of which is capable of dissolving paraffinic hydrocarbons, and the second solvent is used to dissolve naphthenic compounds. These two solvent agents are not used as a mixture, as in the Edeleanu process (sulphur dioxide and benzol), but each is used separately. The most important example of this development is the "duo-sol" extraction process that uses propane and phenol or cresol. Propane simultaneously precipitates the asphalt compounds and dissolves the paraffinic hydrocarbons. Phenol dissolves naphthenic acids and naphthenic hydrocarbons. The selectivity of this process is excellent, and the raffinates obtained are not only high in viscosity index but are exceptionally low in carbon residue, resistant to oxidation, and stable as to color.

[6] *Refiner*, p. 445, 1933.

Fig. 2. Flow diagram of process utilizing chlorex as solvent agent





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CHIEF: What do you mean, World's Champ? Wasn't it Jack Bins who was raving just a few weeks ago about his Champ on rig No. 6?

SONNY: Right you are, Chief, but this baby just broke that record and it's still going strong.

CHIEF: Well, Sonny, I don't get excited any more about these so-called World's Champ drilling lines. I've seen too many of them in my time.

SONNY: Sorry, Chief, thought you'd be interested. Of course, I'm a "Babe in the Woods" when it comes to experience in this business—but I honestly thought we had something here in this drilling line.

CHIEF: Now, don't take me too seriously, Sonny. I'm not surprised that this Roebling line of yours is doing championship stuff. But to tell the truth, it isn't the Champs I'm interested in.

SONNY: What do you mean, Chief? You're not interested in long rope service?

CHIEF: Not at all, Sonny. I am just as interested in long rope service as the next Supt, but it's not the occasional world's record line that counts. It's what all our lines do on the average!

SONNY: I think I get you, Chief.

CHIEF: I think you do, Sonny. It's not the "prima donna" ropes—the ones that grab the limelight every once in a while—that enable us to save money. It's the fact that *all* of our ropes, bunched in together, give us darn long average life. Right here, I'm telling you, Roebling Lines are supreme!

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Air and Air Filters for Diesel Engines

Efficient performance of Diesel engines requires proper control of inlet air—Supercharging increases power output

By ORVILLE ADAMS

INTELLIGENT operation of a Diesel plant requires careful consideration of certain fundamentals by the engineer who wants to correlate theory and practice. Limited knowledge of fundamentals is a definite handicap to the operating man in the field of Diesel engineering. The present purpose, therefore, is to explain the correlation of theory and practice in certain important phases of Diesel engine operation. It is important to consider the services such as fuel, water, and air, over which the manufacturer and designer have little control, but which depend upon the judgment of the operator. Of these, air and inlet requirements of the Diesel engine will be discussed here.

The general properties of air cannot be changed for use in a Diesel engine, desirable as this might be. A Diesel engine requires considerable quantities of air for successful operation, ranging from 2 to 5 cu. ft. per hp. per minute, and it has been recognized that this air must be dust-free, pure and cool as possible. Dust-laden air can cause much damage to an engine in only a few hours of operation. This is demonstrated by the experience with engines operating adjacent to quarries, mills, cotton gins, and dust-creating process industries.

Air filters offered by various manufacturers fall into one of two general classifications: (1) viscous impingement type, or (2) oil-bath type. The viscous impingement type consists of sections called cells, the cells being composed of iron cuttings or wire in a matted form. The purpose of this construction is to present as large an oil-soaked surface as possible to the air. The filter unit or cell is immersed in a special oil to coat the filter material. It is then allowed to drain for several hours before being placed in service.

The oil-bath type of filter consists of a reservoir containing oil and a series of baffles that effectively direct the air against the surface of the oil. There are many variations and combinations of these filters, but they are all based upon the same fundamental principle, i.e., when dust, dirt, or solid particles strike an oil surface they are caught and held by the oil. The air is not affected by this contact with the oiled surface.

The filter must be cleaned and given a new coating of oil at regular intervals, according to the manufacturer's directions. No filter is better than the care exercised in its operation. The filter should be installed in such a manner that it may be serviced and cleaned easily. The filter must also be large enough to permit an unrestricted flow of air to the engine.

ORVILLE ADAMS

was educated at Kentucky State College and served in the technical branch of the army during the World War—After his discharge from the service he was for ten years sales engineer for Diesel engine manufacturers—Since 1930 he has devoted his time largely to the writing of text books and articles for leading technical journals—Is the author of authoritative text books on the Diesel engine that are widely used in technical schools, and at present is preparing a text on Diesel engine thermodynamics for college use—Is also engaged in research and investigation and the preparation of engineering reports on Diesel engine applications.

The usual practice is to place the air intake filters outside the building, preferably several feet above the ground level, away from dust, fumes, and moisture. If the filter is situated in this manner, a suitable housing is necessary. The air near the ground contains more dirt and dust than does the air a few feet above the ground. For this reason, filter housings are sometimes built air-tight, having an intake pipe extending at least 10 ft. above. An air inlet pipe or filter should be situated to avoid proximity to a dust collecting system, process fumes that are harmful to an engine, and to avoid drip water from the roof or from cooling towers being drawn-in with the intake air. Lint, shavings, grit from grinding processes, and corrosive gases are all harmful to an engine. Filter intakes are frequently screened as an additional safeguard against larger particles of dust choking the filter element itself.

The air intake pipe must be large, smooth, and free of sharp bends. Sheet metal is usually satisfactory for either overhead or underground installations. When an underground air pipe may be subject to corrosion, electrolysis, or attack from any minerals present in the soil, glazed sewer tile may be more satisfactory than any other piping. The use of concrete air duct is not good practice unless the interior is well painted or coated by a viscous surfacing to prevent small, gritty particles being loosened and drawn into the engine. Between the filter and the engine, the air ducts may be lined with fairly heavy galvanized metal. The pulsations of air in an inlet or exhaust pipe tend to loosen particles of concrete or mortar, but the surface of tile or sheet metal remains intact.

Air taken from outdoors is cooler than air taken from the engine room, so that a greater weight of air is introduced into the engine cylinder. A long inlet pipe, sharp turns in the piping or ducts, undersized and dirty filters, all tend to restrict the free flow of the air, resulting in a lower absolute pressure,

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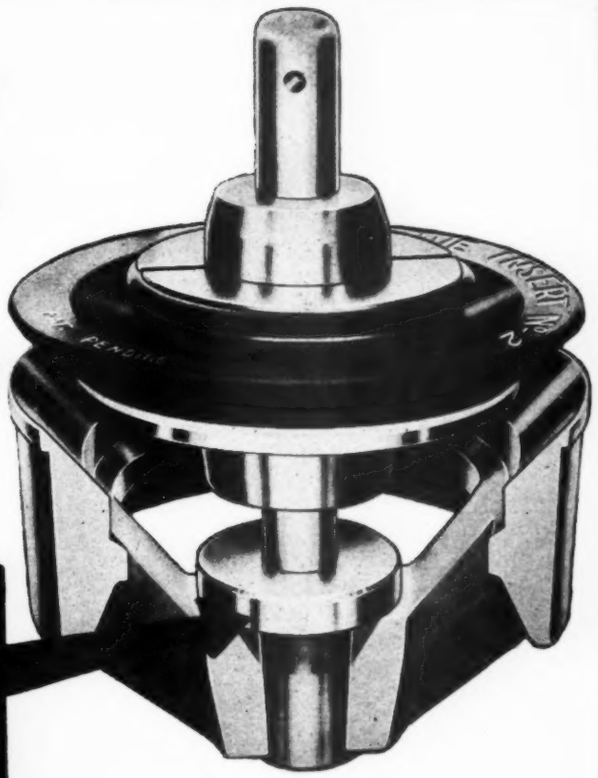

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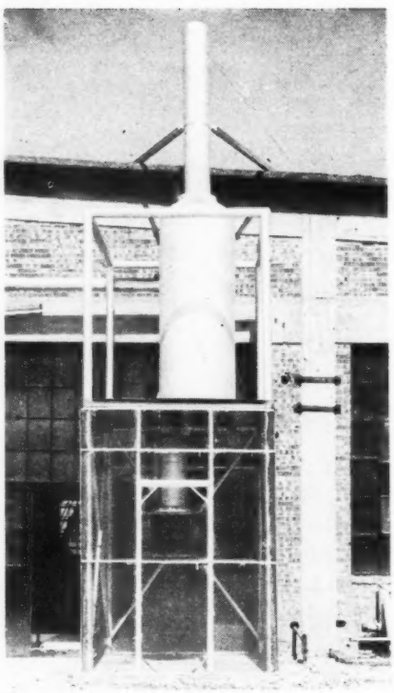
and consequent reduction of density or weight. If the air is taken from the engine room, a window or other ample opening should be provided to admit plenty of outside air to the engine room. When this provision is made for fresh air, the engine does not evacuate the engine room of air, and there is no danger that windows may be broken by the reduction of pressure inside the room. The engine does not suffer for air and have a smoky exhaust, a condition that is observed when there is insufficient air in such an engine room.

In extremely cold climates, it may be advisable to draw air from the engine room until the engine is started, then change to outside air for normal operation. Such a practice will require an inspection plate or opening in the air duct within the engine room, the plate being opened while the engine is being started, but closed after the engine is running, returning to a supply of outside air as soon as the engine is warmed-up sufficiently to take the load.

In the theory of temperature due to compression is found the explanation of the effect of initial air temperature on the final temperature produced by compression for automatic ignition in the Diesel. It may be determined also that an engine is underrated when operating on high inlet air temperature or low suction pressure, either of which reduces the density or weight of the charge of air in the cylinder. The theory by which this behavior is explained is sound and correlates with practice.

Diesel fuels theoretically require approximately 15 lb. of air per lb. of oil for perfect combustion. In actual practice, a Diesel engine uses from two to four times this quantity of air to insure perfect combustion and maintain a clear exhaust. When a Diesel engine burns .40-lb. of fuel per b.hp-hr., it requires $.4 \times 15(2 \text{ to } 4) = 12 \text{ to } 24$ lb. of air per b.hp-hr. Air will vary in density, but in most instances will occupy from 13 to 14 cu. ft. per lb. under normal atmospheric conditions.

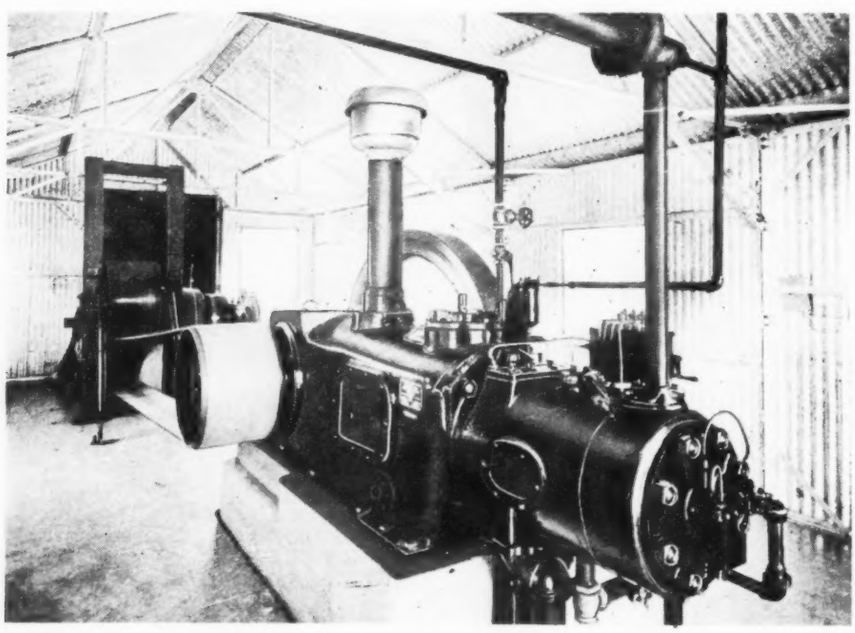


Method of screening the air filter; exhaust silencer is installed above the filter

It follows that the Diesel engine requires from 156 to 336 cu. ft. of air per b.hp. These figures denote the range in which various types and designs of engines operating under a wide variety of conditions will fall. For general purposes, when estimating the air required, it is a good rule to allow 200 to 225 cu. ft. per rated hp-hr. for a 4-cycle engine, and from 250 to 275 cu. ft. per rated hp-hr. for a 2-cycle engine. This difference is accounted for by the fact that the 2-cycle engine wastes some of its air by allowing it to escape from the exhaust ports without entering into combustion. The 2-cycle engine as a rule does not burn as much fuel per stroke, assuming the same cylinder size as the 4-cycle engine. An engine is supercharged for the purpose of obtaining more hp. per cu. ft. of piston displacement. Supercharged, both the 2-cycle and 4-cycle engine would develop one hp. on approximately 200 cu. ft. or 15 lb. of air. These figures refer to free air supplied to the cylinder by a compressor or blower, rather than to the piston displacement volume.

Theoretically one lb. of air, under the conditions assumed, requires the expenditure of 9940 ft-lb. of work when compressed from 14.3 to 20 lb. per sq. in. When all losses are included the actual power expended would be about 15,000 ft-lb. of work per lb. of air delivered, and the density of the air in the cylinder at the beginning of the compression stroke would be increased about 35 percent. In order to compress 15 lb. of air, the amount required for one hp-hr., it would be necessary to expend approximately

$15 \times 15{,}000 = 225{,}000$ ft-lb. of work. Increasing the air density 35 percent should result in an equivalent percentage increase in the amount of energy developed by the engine, or an increase of $.35 \times 60 \times 33{,}000 = 693{,}000$ ft-lb. of work per hp-hr. of engine capacity. This increased capacity is the attractive part of supercharging, and is obtained because more air enters the cylinder and hence more fuel may be burned. This gain in horsepower is not "free." It will require additional fuel although it may not increase the rate of fuel per hp-hr. There will also be the cost of extra blower or compressor equipment, as well as the depreciation and maintenance cost of this added equipment.



Air filter installed on an oil-well pumping unit

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 27

Included in this installment is Part 1 of the subject index prepared to facilitate the use of the Decimal System in accordance with which the Continuous Tables are numbered and cataloged. The index, arranged alphabetically, will be found a valuable aid in the use of the Decimal System as it provides an easy means of finding library material pertaining to the specific subject of interest.

All petroleum engineering literature may be indexed for reference according to the Dewey Decimal System as modified and extended for the petroleum industry by L. C. Uren, professor of petroleum engineering at the University of California. When classified according to these index numbers the material follows in a logical sequence and falls into several logical divisions, as illustrated by the following outline:

Nos. P000-P399—General

Nos. P400-P499—Drilling

Nos. P500-P599—Production

Nos. P600-P699—Transportation and Storage (includes Pipe Line)

Nos. P700-P799—Refining, including

Nos. P770-P799—Natural Gasoline, which may be classified in a separate division (as shown here) if of special interest to the user.

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*This index of the third twelve installments is revised monthly as additional tables are published. A complete index of all tables included in the first twelve installments was published in the May, 1938, issue. The index of the second twelve installments appeared in the June, 1939, issue.

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Alphabetical Subject Index to Decimal System for Classifying Petroleum Engineering Data

Part 1

By LESTER C. UREN
Professor of Petroleum Engineering, University of California, Berkeley, California

EDITOR'S NOTE: Beginning in the issue of November, 1938, and extending through successive issues to June, 1939, *The Petroleum Engineer* published a modernized edition of the Uren Decimal Classification. In accordance with the statement given at the conclusion of this series, in the June issue, *The Petroleum Engineer* now presents an alphabetical arrangement of the same topics that found place in the decimal classification. Until one becomes familiar with the decimal classification, it may be found more convenient to seek the appropriate filing numbers by reference to the alphabetical arrangement of items. The general plan of the classification and suggestions for its use in systematically filing petroleum technology data, will be found in the first installment, printed in the November, 1938, issue.

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VOLUMETRIC EFFICIENCY (E_v) OF NATURAL GAS COMPRESSORS

Compression ratio (r)	Clearance volume, percent of displacement volume														
	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
1.5	0.9348	0.9296	0.9244	0.9192	0.9140	0.9088	0.9036	0.8984	0.8932	0.8880	0.8828	0.8776	0.8724	0.8672	0.8620
1.6	.9338	.9276	.9214	.9152	.9090	.9028	.8966	.8904	.8842	.8780	.8718	.8656	.8594	.8532	.8470
1.7	.9328	.9256	.9184	.9112	.9040	.8968	.8896	.8824	.8752	.8680	.8608	.8536	.8464	.8392	.8320
1.8	.9318	.9236	.9154	.9072	.8990	.8908	.8826	.8744	.8662	.8580	.8498	.8416	.8334	.8252	.8170
1.9	.9308	.9216	.9124	.9032	.8940	.8848	.8756	.8664	.8572	.8480	.8388	.8296	.8204	.8112	.8020
2.0	.9298	.9196	.9094	.8992	.8890	.8788	.8686	.8584	.8482	.8380	.8278	.8176	.8074	.7972	.7870
2.1	.9288	.9176	.9064	.8952	.8840	.8728	.8616	.8504	.8392	.8280	.8168	.8056	.7944	.7832	.7720
2.2	.9278	.9156	.9034	.8912	.8790	.8668	.8546	.8424	.8302	.8180	.8058	.7936	.7814	.7692	.7570
2.3	.9268	.9136	.9004	.8872	.8740	.8608	.8476	.8344	.8212	.8080	.7948	.7816	.7684	.7552	.7420
2.4	.9258	.9116	.8974	.8832	.8690	.8548	.8406	.8264	.8122	.7980	.7838	.7696	.7554	.7412	.7270
2.5	.9248	.9096	.8944	.8792	.8640	.8488	.8336	.8184	.8032	.7880	.7728	.7576	.7424	.7272	.7120
2.6	.9238	.9076	.8914	.8752	.8590	.8428	.8266	.8104	.7942	.7780	.7618	.7456	.7294	.7132	.6970
2.7	.9228	.9056	.8884	.8712	.8540	.8368	.8196	.8024	.7852	.7680	.7508	.7336	.7164	.6992	.6820
2.8	.9218	.9036	.8854	.8672	.8490	.8308	.8126	.7944	.7762	.7580	.7398	.7216	.7034	.6852	.6670
2.9	.9208	.9016	.8824	.8632	.8440	.8248	.8056	.7864	.7672	.7480	.7288	.7096	.6904	.6712	.6520
3.0	.9198	.8996	.8794	.8592	.8390	.8188	.7986	.7784	.7582	.7380	.7178	.6976	.6774	.6572	.6370
3.1	.9188	.8976	.8764	.8552	.8340	.8128	.7916	.7704	.7492	.7280	.7068	.6856	.6644	.6432	.6220
3.2	.9178	.8956	.8734	.8512	.8290	.8068	.7846	.7624	.7402	.7180	.6958	.6736	.6514	.6292	.6070
3.3	.9168	.8936	.8704	.8472	.8240	.8008	.7776	.7544	.7312	.7080	.6848	.6616	.6384	.6152	.5920
3.4	.9158	.8916	.8674	.8432	.8190	.7948	.7706	.7464	.7222	.6980	.6738	.6496	.6254	.6012	.5770
3.5	.9148	.8896	.8644	.8392	.8140	.7888	.7636	.7384	.7132	.6880	.6628	.6376	.6124	.5872	.5620
3.6	.9138	.8876	.8614	.8352	.8090	.7828	.7566	.7304	.7042	.6780	.6518	.6256	.5994	.5732	.5470
3.7	.9128	.8856	.8584	.8312	.8040	.7768	.7496	.7224	.6952	.6680	.6408	.6136	.5864	.5592	.5320
3.8	.9118	.8836	.8554	.8272	.7990	.7708	.7426	.7144	.6862	.6580	.6298	.6016	.5734	.5452	.5170
3.9	.9108	.8816	.8524	.8232	.7940	.7648	.7356	.7064	.6772	.6480	.6188	.5896	.5604	.5312	.5020
4.0	.9098	.8796	.8494	.8192	.7890	.7588	.7286	.6984	.6682	.6380	.6078	.5776	.5474	.5172	.4870
4.1	.9088	.8776	.8464	.8152	.7840	.7528	.7216	.6904	.6592	.6280	.5968	.5656	.5344	.5032	.4720
4.2	.9078	.8756	.8434	.8112	.7790	.7468	.7146	.6824	.6502	.6180	.5858	.5536	.5214	.4892	.4570
4.3	.9068	.8736	.8404	.8072	.7740	.7408	.7076	.6744	.6412	.6080	.5748	.5416	.5084	.4752	.4420
4.4	.9058	.8716	.8374	.8032	.7690	.7348	.7006	.6664	.6322	.5980	.5638	.5296	.4954	.4612	.4270
4.5	.9048	.8696	.8344	.7992	.7640	.7288	.6936	.6584	.6232	.5880	.5528	.5176	.4824	.4472	.4120
4.6	.9038	.8676	.8314	.7952	.7590	.7228	.6866	.6504	.6142	.5780	.5418	.5056	.4694	.4332	.3970
4.7	.9028	.8656	.8284	.7912	.7540	.7168	.6796	.6424	.6052	.5680	.5308	.4936	.4564	.4192	.3820
4.8	.9018	.8636	.8254	.7872	.7490	.7108	.6726	.6344	.5962	.5580	.5198	.4816	.4434	.4052	.3670
4.9	.9008	.8616	.8224	.7832	.7440	.7048	.6656	.6264	.5872	.5480	.5088	.4696	.4304	.3912	.3520
5.0	.8998	.8596	.8194	.7792	.7390	.6988	.6586	.6184	.5782	.5380	.4978	.4576	.4174	.3772	.3370
5.1	.8988	.8576	.8164	.7752	.7340	.6928	.6516	.6104	.5692	.5280	.4868	.4456	.4044	.3632	.3220
5.2	.8978	.8556	.8134	.7712	.7290	.6868	.6446	.6024	.5602	.5180	.4758	.4336	.3914	.3492	.3070
5.3	.8968	.8536	.8104	.7672	.7240	.6808	.6376	.5944	.5512	.5080	.4648	.4216	.3784	.3352	.2920
5.4	.8958	.8516	.8074	.7632	.7190	.6748	.6306	.5864	.5422	.4980	.4538	.4096	.3654	.3212	.2770
5.5	.8948	.8496	.8044	.7592	.7140	.6688	.6236	.5784	.5332	.4880	.4428	.3976	.3524	.3072	.2620
5.6	.8938	.8476	.8014	.7552	.7090	.6628	.6166	.5704	.5242	.4780	.4318	.3856	.3394	.2932	.2470
5.7	.8928	.8456	.7984	.7512	.7040	.6568	.6096	.5624	.5152	.4680	.4208	.3736	.3264	.2792	.2320
5.8	.8918	.8436	.7954	.7472	.6990	.6508	.6026	.5544	.5062	.4580	.4098	.3616	.3134	.2652	.2170
5.9	.8908	.8416	.7924	.7432	.6940	.6448	.5956	.5464	.4972	.4480	.3988	.3496	.3004	.2512	.2020

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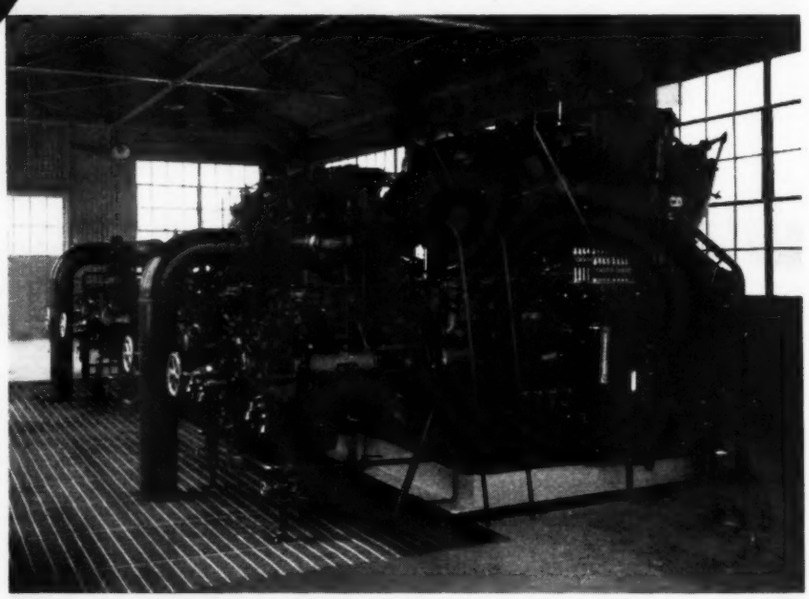

THE COOPER-BESSEMER CORPORATION

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631 Spring St. Shreveport, La.
Magnolia Building Dallas, Texas
529 M & M Building, Houston, Texas

LENGTHS AND SIZES OF WIRE ROPE FOR EQUIVALENT STRENGTH IN DERRICK GUY LINES

Basis of load determination	Height of derrick-end of guy line above ground, feet	Diameter of wire line																	
		3/4-in.		5/8-in.		9/16-in.		1/2-in.		7/16-in.		3/8-in.		5/16-in.		9/32-in.		1/4-in.		7/32-in.	
		Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet	Minim. horizon. distance, feet	Length of guy line, feet
If wind and other loads on derrick require 1/4-in. guy lines at an angle of 45 degrees	60	5	60+	7	60+	8 1/4	61	11	61	14 1/2	61	20	63	28	66	36 3/4	70	60	85	106 3/4	122
	70	5 1/2	70+	8	70+	9 3/4	71	13	71	17	72	23 1/2	74	32 1/2	77	42 3/4	82	70	99	124 1/2	143
	80	6	80+	9 1/4	81	11 1/4	81	14 3/4	81	19 1/2	82	26 3/4	84	37 1/4	88	49	94	80	113	142 1/4	163
	90	6 3/4	90+	10 1/2	91	12 1/2	91	16 1/2	92	21 3/4	92	30	95	42	99	55	106	90	127	160	184
	100	7 1/2	100+	11 1/2	101	14	101	18 1/2	102	24 1/4	102	33 1/2	105	46 1/2	110	61 1/4	117	100	141	178	204
	110	8 1/4	110+	12 3/4	111	15 1/2	111	20 1/4	112	26 3/4	113	36 3/4	116	51 1/4	121	67 1/2	129	110	156	195 3/4	225
	120	9	120+	14	121	16 3/4	121	22 1/4	122	29	123	40	127	56	132	73 1/2	141	120	170	213 1/2	245
	130	9 3/4	130+	15	131	18 1/4	131	24	132	31 1/2	133	43 1/2	137	60 1/2	143	79 1/2	152	130	184	231 1/4	265
	140	10 1/2	140+	16 1/4	141	19 1/2	141	26	142	34	143	46 3/4	148	65 1/4	154	85 3/4	164	140	198	249	286
	150	11 1/4	150+	17 1/2	151	21	151	27 3/4	153	36 1/2	154	50	158	70	165	92	176	150	212	267	306
	160	12	160+	18 1/2	161	22 1/2	162	29 1/2	163	39	164	53 1/2	169	74 1/2	176	98	188	160	226	284 3/4	327
If wind and other loads on derrick require 9/32-in. guy lines at an angle of 45 degrees	60	6 1/2	60+	9 1/2	61	11 1/2	61	15	62	20 1/4	63	28 1/2	66	41 1/4	73	60	85	198	207		
	70	7 3/4	70+	11	71	13 1/2	71	17 1/2	72	23 1/2	74	33	77	48	85	70	99	231	242		
	80	8 3/4	80+	12 1/2	81	15 1/2	81	20	83	27	84	37 3/4	89	55	97	80	113	264	276		
	90	10	91	14 1/4	91	17 1/2	92	22 3/4	93	30	95	42 1/2	100	61 3/4	109	90	127	297	311		
	100	11	101	15 3/4	101	19 1/2	102	25 1/4	103	33 3/4	106	47 1/4	111	68 3/4	121	100	141	331	345		
	110	12	111	17 1/2	111	21 1/4	112	27 3/4	113	37	116	52	122	75 1/2	133	110	156	364	380		
	120	13 1/4	121	19	122	23 1/4	122	30 1/4	124	40 1/2	127	56 3/4	133	82 1/2	146	120	170	397	414		
	130	14 1/2	131	20 1/2	132	25 1/4	132	32 3/4	134	44	137	61 1/2	144	89 1/4	158	130	184	430	449		
	140	15 1/2	141	22	142	27 1/4	143	35 1/4	144	47 1/4	148	66 1/4	155	96 1/4	170	140	198	463	483		
	150	16 1/2	151	23 3/4	152	29	153	37 3/4	155	50 1/2	158	71	166	103	182	150	212	496	518		
	160	17 3/4	161	25 1/4	162	31	163	40 1/4	165	54	169	75 3/4	177	110	194	160	226	529	553		
If wind and other loads on derrick require 5/16-in. guy lines at an angle of 45 degrees	60	8 1/4	61	11 3/4	61	14 1/2	62	19 1/4	63	25 3/4	65	37 3/4	71	60	85	111	126				
	70	9 1/2	71	13 3/4	71	17	72	22 1/2	74	30	76	44	83	70	99	130	147				
	80	11	81	15 3/4	82	19 1/2	82	25 3/4	84	34 1/2	87	50 1/4	95	80	113	148	169				
	90	12 1/4	91	17 3/4	92	21 3/4	93	29	95	38 3/4	98	56 1/2	106	90	127	167	190				
	100	13 3/4	101	19 3/4	102	24 1/4	103	32	105	43	109	62 3/4	118	100	141	185	211				
	110	15	111	21 3/4	112	26 3/4	113	35 1/4	116	47 1/2	120	69	130	110	156	204	232				
	120	16 1/2	121	23 1/2	122	29	123	38 1/2	126	51 3/4	131	75 1/2	142	120	170	223	253				
	130	17 3/4	131	25 1/2	133	31 1/2	134	41 3/4	137	56	142	81 3/4	154	130	184	241	274				
	140	19 1/4	141	27 1/2	143	34	144	45	147	60 1/4	153	88	165	140	198	260	295				
	150	20 1/2	151	29 1/2	153	36 1/2	154	48 1/4	158	64 3/4	163	94 1/4	177	150	212	278	316				
	160	22	162	31 1/2	163	39	165	51 1/2	168	69	174	101	189	160	226	297	337				

†This table may also be filed as P 094.13

Loads vary in derricks so that it is not practicable to include specific recommendations in this table. It is common practice, however, to use 1/4-in., 9/32-in., or 5/16-in. guy lines at an angle of 45 degrees and it is upon these conditions that the above values are based.

Purpose of Table: It is sometimes desirable or necessary to vary the distance to the deadman or guy-line anchor from the derrick. The closer the anchor to the derrick the greater the stress in the line and, therefore, the larger must be the wire rope that is used. Table shows the minimum distance that should be employed if a given size wire line is used. Conversely, if the distance to the guy-line anchor is the restricting factor, the size wire line to use is shown.

Example: Preliminary calculations have shown that a 1/4-in. wire rope at an angle of 45 degrees will be required to guy a 136-ft. derrick safely. It is planned to tie the guy-wires to the derrick at the thrible-board, which is 70 ft. above the ground level. The maximum distance to one guy-line anchor can only be 35 feet. What size line should be used?

Solution: In the second line of the table, it is found that a 7/32-in. wire line may be used if the minimum horizontal distance is not less than 32 1/2 ft. Wire line of this size may, therefore, be used to obtain the safety required.

Note: Values for 3/4-in. to 7/32-in. wire rope are included to provide for emergencies when available space around the derrick is extremely limited and these heavier lines are required.

Calculations in table are based on strength of 7-wire standard steel guy strand, using a safety factor of 5.

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VOLUME OF GAS LOST IN BLOWDOWN OF LINE

(Gas volumes in table are in M cu. ft. per 1000 ft. of line)

Initial line pressure on shut-in section, lb. per sq. in., ga.	Nominal diameter of line, in.																	
	2	2½	3	3½	4	5	6	8	10	12	14	15	16	17	18	20	22	24
25	0.040	0.057	0.088	0.117	0.151	0.237	0.342	0.606	0.967	1.360	1.634	1.890	2.164	2.446	2.747	3.423	4.175	5.000
50	.080	.113	.175	.234	.302	.474	.685	1.213	1.934	2.722	3.269	3.781	4.330	4.894	5.495	6.849	8.353	10.00
75	.119	.170	.263	.352	.453	.711	1.027	1.819	2.901	4.082	4.903	5.670	6.494	7.340	8.242	10.27	12.53	15.00
100	0.159	0.227	0.350	0.469	0.603	0.948	1.369	2.425	3.868	5.443	6.538	7.561	8.659	9.788	10.99	13.70	16.71	20.01
125	.199	.284	.438	.586	.754	1.185	1.712	3.031	4.835	6.803	8.172	9.451	10.82	12.23	13.74	17.12	20.88	25.01
150	.239	.340	.526	.703	.905	1.422	2.054	3.638	5.803	8.165	9.808	11.34	12.99	14.68	16.49	20.55	25.06	30.01
175	.278	.397	.614	.821	1.056	1.660	2.397	4.246	6.772	9.529	11.45	13.24	15.16	17.14	19.24	23.98	29.25	35.03
200	0.318	0.454	0.701	0.937	1.207	1.896	2.738	4.850	7.735	10.88	13.07	15.12	17.32	19.57	21.98	27.39	33.41	40.01
225	.358	.511	.789	1.055	1.358	2.134	3.081	5.457	8.705	12.25	14.71	17.01	19.49	22.02	24.73	30.82	37.59	45.02
250	.397	.567	.876	1.172	1.508	2.370	3.422	6.061	9.668	13.60	16.34	18.90	21.64	24.46	27.47	34.23	41.75	50.00
275	.437	.624	.964	1.289	1.659	2.607	3.765	6.669	10.64	14.97	17.98	20.79	23.81	26.91	30.22	37.66	45.94	55.02
300	0.477	0.681	1.051	1.406	1.811	2.845	4.108	7.277	11.61	16.33	19.62	22.69	25.98	29.37	32.97	41.10	50.12	60.03
325	.517	.737	1.139	1.523	1.961	3.081	4.449	7.881	12.57	17.69	21.24	24.57	28.14	31.80	35.71	44.51	54.28	65.01
350	.557	.794	1.227	1.641	2.112	3.318	4.792	8.488	13.54	19.05	22.88	26.46	30.31	34.26	38.47	47.94	58.47	70.02
375	.596	.851	1.314	1.758	2.263	3.556	5.135	9.096	14.51	20.41	24.52	28.36	32.48	36.71	41.22	51.37	62.65	75.04
400	0.636	0.908	1.402	1.875	2.414	3.792	5.476	9.700	15.47	21.77	26.15	30.24	34.63	39.15	43.96	54.78	66.81	80.02
425	.676	.965	1.489	1.992	2.565	4.029	5.819	10.31	16.44	23.13	27.79	32.13	36.80	41.60	46.71	58.21	71.00	85.03
450	.716	1.021	1.577	2.110	2.716	4.267	6.162	10.91	17.41	24.50	29.42	34.03	38.97	44.05	49.46	61.64	75.18	90.04
475	.755	1.078	1.664	2.226	2.866	4.503	6.503	11.52	18.37	25.85	31.05	35.91	41.13	46.49	52.20	65.05	79.34	95.03
500	0.795	1.135	1.752	2.344	3.017	4.741	6.846	12.13	19.34	27.22	32.69	37.81	43.30	48.94	54.95	68.49	83.53	100.0
525	.835	1.192	1.840	2.461	3.169	4.978	7.190	12.73	20.31	28.58	34.33	39.70	45.47	51.39	57.71	71.92	87.71	105.1
550	.875	1.248	1.927	2.578	3.318	5.214	7.531	13.34	21.27	29.93	35.96	41.58	47.62	53.83	60.44	75.33	91.87	110.0
575	.915	1.305	2.015	2.695	3.470	5.452	7.874	13.95	22.24	31.30	37.59	43.48	49.79	56.28	63.20	78.76	96.06	115.0
600	0.954	1.362	2.103	2.813	3.621	5.689	8.217	14.55	23.21	32.66	39.23	45.37	51.96	58.73	65.95	82.19	100.2	120.1
625	.994	1.418	2.190	2.929	3.772	5.925	8.558	15.16	24.18	34.02	40.86	47.25	54.12	61.17	68.69	85.60	104.4	125.0
650	1.034	1.475	2.278	3.047	3.923	6.163	8.901	15.76	25.14	35.38	42.50	49.15	56.29	63.62	71.44	89.03	108.6	130.1
675	1.074	1.532	2.366	3.164	4.074	6.401	9.244	16.37	26.11	36.74	44.14	51.04	58.46	66.07	74.19	92.46	112.8	135.1
700	1.113	1.589	2.453	3.281	4.224	6.637	9.585	16.98	27.08	38.10	45.76	52.93	60.61	68.51	76.93	95.88	116.9	140.0
725	1.153	1.646	2.541	3.398	4.375	6.874	9.928	17.58	28.05	39.46	47.40	54.82	62.78	70.96	79.68	99.31	121.1	145.1
750	1.193	1.702	2.628	3.515	4.526	7.110	10.27	18.19	29.01	40.82	49.03	56.70	64.94	73.40	82.42	102.7	125.3	150.0
775	1.233	1.759	2.716	3.633	4.677	7.348	10.61	18.80	29.98	42.18	50.67	58.60	67.11	75.85	85.17	106.1	129.5	155.1
800	1.272	1.816	2.804	3.750	4.828	7.585	10.95	19.40	30.95	43.55	52.31	60.49	69.28	78.31	87.93	109.6	133.6	160.1
825	1.312	1.872	2.891	3.867	4.978	7.821	11.30	20.01	31.91	44.90	53.93	62.37	71.43	80.74	90.66	113.0	137.8	165.1
850	1.352	1.929	2.979	3.984	5.130	8.059	11.64	20.61	32.88	46.27	55.57	64.27	73.60	83.19	93.42	116.4	142.0	170.1
875	1.392	1.986	3.067	4.102	5.281	8.296	11.98	21.22	33.85	47.63	57.21	66.16	75.77	85.65	96.17	119.9	146.2	175.1

Note: Volumes are based on an atmospheric pressure of 14.65 lb. per sq. in., uncorrected for deviation from Boyle's law.

Example: A section of 18-in. line is partly blown-down between two main line gates at Stations 1563+49 and 2083+65, respectively. Initial pressure on the section is 750 lb. per sq. in. Pressure on the line at the end of the blow is 175 lb. per sq. in. What is the volume of gast lost during the blowdown?

Solution: 208365 — 156349 = 52016 ft., or 52.016 M ft. of line.

Volume of gas lost in blowdown of 1000 ft. of 18-in. line from 750 lb. per sq. in. ga. to atmospheric pressure = 82.42 M cu. ft.

Volume of gas lost in blowdown of 1000 ft. of 18-in. line from 175 lb. per sq. in. ga. to atmospheric pressure = 19.24 M cu. ft.

Volume of gas lost in blowdown of 1000 ft. of 18-in. line from 750 to 175 lb. per sq. in. ga. pressure = 63.18 M cu. ft.

63.18 times 52.016 = 3286.4 M cu. ft. of gas lost in blowdown

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actual →	2.000	2.125	2.250	2.375	2.500	2.625	2.750	2.875	3.000	3.125	3.250	3.375
Speed—service												
50 r.p.m.												
A	8.0-10.	9.6-12.	11.-14.	13.-17.	16.-20.	18.-23.	21.-26.	24.-30.	27.-34.	31.-38.	34.-43.	38.-48.
B	4.5-5.7	5.4-6.8	6.4-8.1	7.5-9.5	8.8-11.	10.-13.	12.-15.	13.-17.	15.-19.	17.-22.	19.-24.	22.-27.
C	3.2-4.0	3.8-4.8	4.6-5.7	5.4-6.7	6.3-7.8	7.2-9.0	8.3-10.	9.5-12.	11.-14.	12.-15.	14.-17.	15.-19.
100 r.p.m.												
A	16.-20.	19.-24.	23.-28.	27.-34.	31.-39.	36.-45.	42.-52.	48.-59.	54.-68.	61.-76.	69.-86.	77.-96.
B	8.9-11.	11.-14.	13.-16.	15.-19.	17.-22.	20.-26.	23.-30.	26.-34.	30.-39.	34.-44.	38.-49.	43.-55.
C	6.4-8.0	7.7-9.6	9.1-11	11.-13.	13.-16.	14.-18.	17.-21.	19.-24.	22.-27.	24.-31.	27.-34.	31.-38.
150 r.p.m.												
A	24.-30.	29.-36.	34.-43.	40.-50.	47.-59.	54.-68.	62.-78.	71.-89.	81.-100.	92.-115	105.-130.	115.-145.
B	13.-17.	16.-21.	19.-24.	22.-29.	26.-33.	30.-39.	35.-45.	40.-51.	45.-58.	51.-65	57.-73.	64.-82.
C	9.6-12.	12.-14.	14.-17	16.-20.	19.-23.	22.-27.	25.-31.	29.-36.	33.-41.	37.-46.	41.-51.	46.-58.
200 r.p.m.												
A	32.-40.	38.-48.	46.-57.	54.-67.	63.-78.	72.-90.	83.-105.	95.-120.	110.-135.	120.-155.	135.-170.	155.-190.
B	18.-23.	21.-27.	25.-33.	30.-38.	35.-45.	40.-52.	46.-59.	53.-68.	60.-78.	68.-87.	76 -98.	85.-110
C	13.-16.	15.-19.	18.-23.	21.-27.	25.-31.	29.-36.	33.-42.	38.-48.	43.-54.	49.-61.	55.-69.	62.-77.
250 r.p.m.												
A	40.-50.	48.-60.	57.-71.	67.-84.	78.-98.	90.-115.	105.-130.	120.-150.	135.-170.	155.-190.	170.-215.	190.-240.
B	22.-29.	27.-34.	32.-41.	37.-48.	43 -56.	50.-65.	58.-74.	66.-85.	75.-97.	85.-110.	95.-125.	105.-135.
C	16.-20.	19.-24.	23.-28.	27.-34.	31.-39.	36.-45.	42.-52.	48.-59.	54.-68.	61.-76.	69.-86.	77.-96.
300 r.p.m												
A	48.-60.	58.-72.	68.-85.	80.-100.	94.-115.	110.-135.	125.-155.	145.-180.	165.-205.	185.-230.	205.-255.	230.-290.
B	27.-34.	32.-41.	38.-49.	45.-57	52.-67.	60. 78.	69.-89.	79.-100.	90.-115.	100.-130.	115 -145.	130.-165.
C	19.-24.	23.-29.	27.-34.	32.-40.	38.-47.	43.-54.	50.-62.	57.-71.	65.-81.	73.-92.	82.-105.	92 -115.
350 r.p.m.												
A	56.-70.	67.-84.	80.-100.	94.-115.	110.-135.	125.-160.	145.-180	165.-210.	190.-235.	215.-265.	240.-300.	270.-335.
B	31.-40.	37.-48.	44.-57.	52.-67.	61.-78.	70.-90.	81.-105.	92.-120.	105.-135.	120.-155	135.-170.	150.-190.
C	22.-28.	27.-34.	32.-40.	38.-47.	44.-55.	51.-63.	58.-73.	67.-83.	76.-95.	85.-105.	96.-120.	110.-135.
400 r.p.m.												
A	64.-80.	77.-96.	91.-115.	105.-135.	125.-155.	145.-180.	165.-210.	190.-240.	215.-270.	245.-305.	275.-345.	310.-385.
B	36.-46.	43.-55.	51.-65.	59.-77.	69.-89.	80.-100.	92 -120.	105.-135.	120.-155.	135.-175.	150.-195.	170.-220.
C	26.-32.	31.-38.	36.-46.	43.-54.	50.-63	58.-72.	67.-83.	76.-95.	87.-110.	98.-120.	110.-135.	125 -155.
450 r.p.m.												
A	72.-90.	86.-110.	105.-130.	120.-150.	140.-175.	165.-205.	185.-235.	215.-265.	245.-305.	275.-345.	310.-385.	345.-430.
B	40.-51.	48.-62.	57.-73.	67.-86.	78.-100.	90.-115.	105.-135.	120.-155.	135.-175.	155.-195.	170.-220.	190.-245
C	29.-36.	35.-43.	41.-51.	48.-60.	56.-70.	65.-81.	75.-94.	86.-107.	98.-120.	110.-135.	135.-170.	140.-175.
500 r.p.m.												
A	80.-100.	96.-120.	115.-145.	135.-165.	155.-195.	180.-225.	210.-260.	240.-295.	270.-340.	305.-380.	345.-430.	385.-480.
B	44.-57.	53.-69.	63.-81.	75.-96.	87.-110.	100.-130.	115.-150.	130.-170.	150.-195.	170.-220.	190.-245.	215.-275.
C	32.-40.	38.-48	46.-57.	54.-67.	63.-78.	72.-90.	83.-105.	95.-119.	110.-135.	120.-155.	135.-170.	155.-190.
750 r.p.m.												
A	120.-150.	145.-180.	170.-215.	200.-250.	235.-295.	270.-340.	310.-390.	355.-445.	405.-510.	460.-570.	515.-645.	575.-720.
B	67.-86.	80.-105.	95.-120.	110.-145	130.-165.	150.-195.	175.-225.	200.-255.	225.-290.	255.-325.	285.-365.	320.-410.
C	48.-60.	58.-72.	68.-85.	80.-100.	94.-115.	110.-135.	125 -155.	145.-180.	165.-205.	185.-230.	205.-255.	230.-290.
1000 r.p.m.												
A	160.-200.	190.-240.	230.-285.	270.-335.	315.-390.	360.-450.	415 -520.	475.-595.	545.-680.	610.-765.	685.-860.	770.-960.
B	89.-114.	110.-135.	130.-165.	150.-190.	170.-225.	200.-260.	230.-295.	265.-340.	300.-390.	340.-435.	380.-490.	425.-550.
C	64.-80.	77.-96.	91.-115.	105.-135.	125.-155.	145.-180.	165.-210.	190.-240.	215.-270.	245.-305.	275.-345.	310.-385.
1250 r.p.m.												
A	200.-350	240.-300.	285.-355.	335.-420.	390.-490.	450.-565.	520.-650.	595.-745.	680.-850.	765.-955.	860.-1070.	960.-1200.
B	110.-145.	135.-170.	160.-205.	185.-240.	215.-280.	250.-325.	290.-375.	330.-425.	375.-485.	425.-545.	475.-615.	535.-690.
C	80.-100.	96.-120.	115.-145.	135.-165.	155.-195.	180.-225.	210.-260.	240.-295.	270.-340.	305.-380.	345.-430.	385.-480.
1500 r.p.m.												
A	240.-300.	290.-360.	340.-425.	400.-505.	470.-585.	545.-680.	625.-780.	715.-890.	815.-1020.	915.-1140.	1030.-1290.	1150.-1440.
B	135.-170.	160.-205.	190.-245.	220.-285.	260.-335.	300.-385.	345.-445.	395.-510.	455.-580.	510.-655.	575.-735.	640.-825.
C	96.-120.	115.-145.	135.-170.	160.-200.	185.-235.	215.-270.	250.-310.	285.-355.	325.-405.	365.-460.	410.-515.	460.-575.

Service symbols:

A Shafts subjected to torque only; short countershafts having pulleys or gears close to bearings.
B First receiving shafts.
C Head shafts carrying main driving pulley or gear, if well supported by bearings.

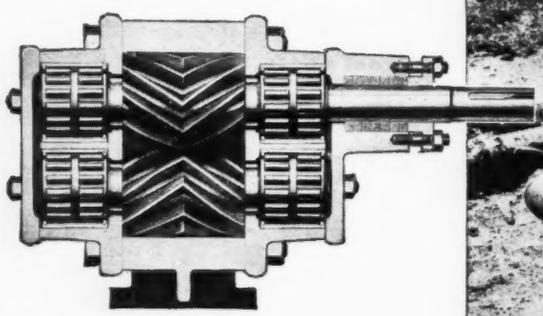
Note: The two values given in each instance do **not** represent limits of a range of horsepower values. The first value is the maximum h.p. recommended for turned shafting; the second value is the maximum h.p. recommended for cold-rolled shafting.

Above values apply only when bearings and loads on shaft are proportioned so that critical speed of the shaft is not exceeded.

[1]Diameters included in table are restricted to those approved by the A.P.I.

SMOOTH GOING...ON HYATTS

Pumps built by the WORTHINGTON PUMP AND MACHINERY CORPORATION are widely used throughout the petroleum industry. As the cutaway illustration (below left) indicates, Hyatts carry the load.



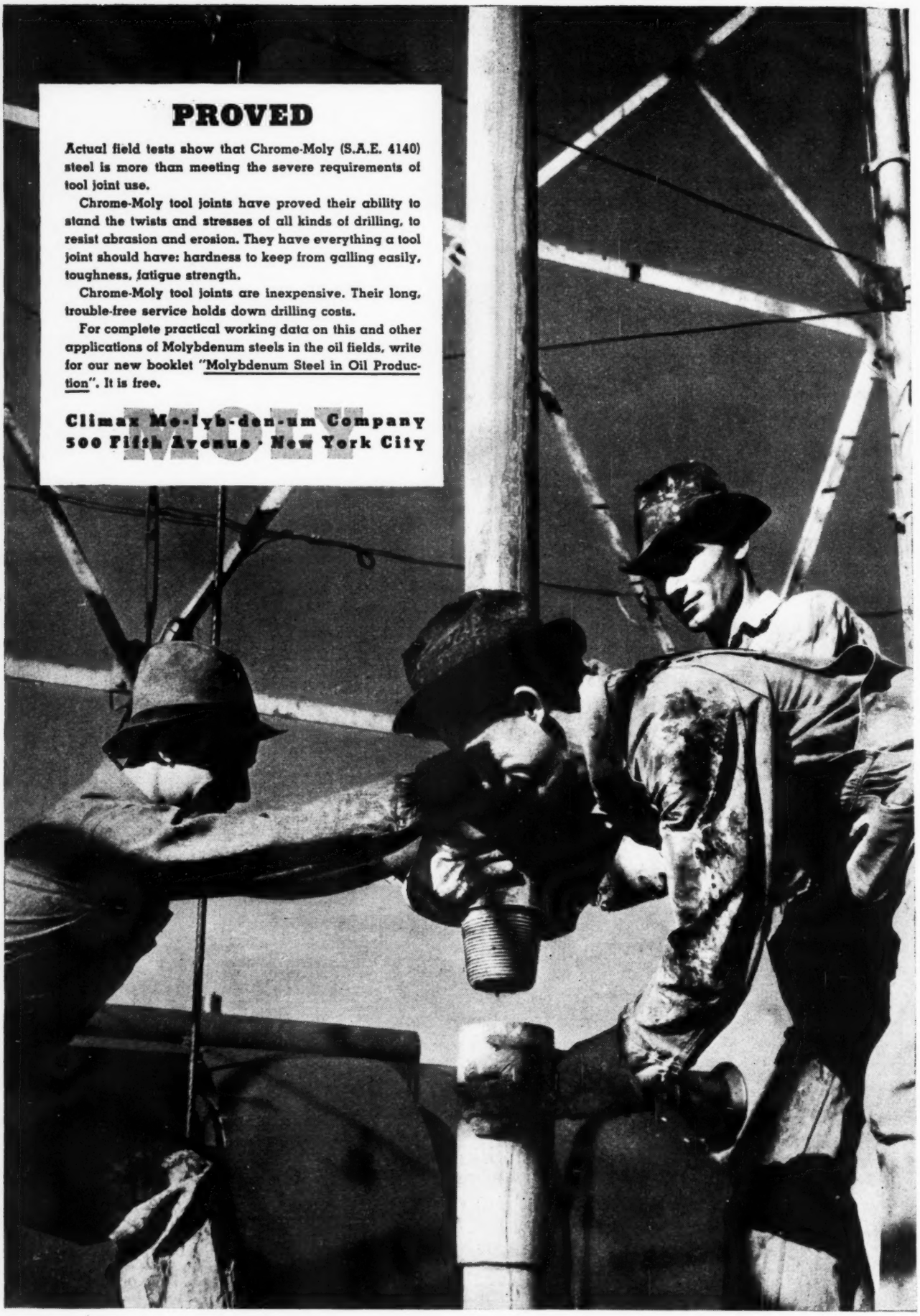
Built for speed and endurance under precision standards, Hyatt Roller Bearings play an essential role in the smooth functioning of machinery. They absorb the uneven surges of force...they conserve power...they promote operating efficiencies. They avoid friction, wear, attention, and replacement. It is this kind of performance and economy that Hyatts add regularly to new equipment design . . . and explains why leading builders of machinery use them year after year in ever-increasing numbers. Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Chicago, Pittsburgh, Detroit, and San Francisco.

HYATT *Roller Bearings*

NET WEIGHT OF 3½-IN. DRILL PIPE IN ROTARY MUD, LB.

Length of string of drill pipe, ft.	8.50 drill pipe				11.20 drill pipe				13.30 drill pipe			
	Weight of fluid				Weight of fluid				Weight of fluid			
	12.0 lb. per gal.	13.4 lb. per gal.	14.7 lb. per gal.	16.0 lb. per gal.	12.0 lb. per gal.	13.4 lb. per gal.	14.7 lb. per gal.	16.0 lb. per gal.	12.0 lb. per gal.	13.4 lb. per gal.	14.7 lb. per gal.	16.0 lb. per gal.
	90 lb. per cu. ft.	100 lb. per cu. ft.	110 lb. per cu. ft.	120 lb. per cu. ft.	90 lb. per cu. ft.	100 lb. per cu. ft.	110 lb. per cu. ft.	120 lb. per cu. ft.	90 lb. per cu. ft.	100 lb. per cu. ft.	110 lb. per cu. ft.	120 lb. per cu. ft.
2,000	14,840	14,600	14,360	14,120	19,660	19,360	19,060	18,750	23,470	23,120	22,770	22,420
2,200	16,320	16,060	15,800	15,530	21,630	21,300	20,960	20,630	25,810	25,430	25,050	24,670
2,400	17,810	17,520	17,230	16,940	23,600	23,230	22,870	22,500	28,160	27,740	27,330	26,910
2,600	19,290	18,980	18,670	18,360	25,560	25,170	24,770	24,380	30,510	30,060	29,600	29,150
2,800	20,780	20,440	20,100	19,770	27,530	27,100	26,680	26,250	32,860	32,370	31,880	31,390
3,000	22,260	21,900	21,540	21,180	29,500	29,040	28,580	28,130	35,200	34,680	34,160	33,640
3,200	23,740	23,360	22,980	22,590	31,460	30,980	30,490	30,000	37,550	36,990	36,440	35,880
3,400	25,230	24,820	24,410	24,000	33,430	32,910	32,400	31,880	39,900	39,300	38,710	38,120
3,600	26,710	26,280	25,850	25,420	35,400	34,850	34,300	33,750	42,240	41,620	40,990	40,360
3,800	28,200	27,740	27,280	26,830	37,360	36,780	36,210	35,630	44,590	43,930	43,270	42,610
4,000	29,680	29,200	28,720	28,240	39,330	38,720	38,110	37,500	46,940	46,240	45,540	44,850
4,200	31,160	30,660	30,160	29,650	41,290	40,660	40,020	39,380	49,280	48,550	47,820	47,090
4,400	32,650	32,120	31,590	31,060	43,260	42,590	41,920	41,250	51,630	50,860	50,100	49,330
4,600	34,130	33,580	33,030	32,480	45,230	44,530	43,830	43,130	53,980	53,180	52,380	51,580
4,800	35,620	35,040	34,460	33,890	47,190	46,460	45,730	45,000	56,320	55,490	54,650	53,820
5,000	37,100	36,500	35,900	35,300	49,160	48,400	47,640	46,880	58,670	57,800	56,930	56,060
5,200	38,580	37,960	37,340	36,710	51,130	50,340	49,550	48,760	61,020	60,110	59,210	58,300
5,400	40,070	39,420	38,770	38,120	53,090	52,270	51,450	50,630	63,360	62,420	61,480	60,540
5,600	41,550	40,880	40,210	39,540	55,060	54,210	53,360	52,510	65,710	64,740	63,760	62,790
5,800	43,040	42,340	41,640	40,950	57,030	56,140	55,260	54,380	68,060	67,050	66,040	65,030
6,000	44,520	43,800	43,080	42,360	58,990	58,080	57,170	56,260	70,400	69,360	68,320	67,270
6,200	46,000	45,260	44,520	43,770	60,960	60,020	59,070	58,130	72,750	71,670	70,590	69,510
6,400	47,490	46,720	45,950	45,180	62,920	61,950	60,980	60,010	75,100	73,980	72,870	71,760
6,600	48,970	48,180	47,390	46,600	64,890	63,890	62,880	61,880	77,440	76,300	75,150	74,000
6,800	50,460	49,640	48,820	48,010	66,860	65,820	64,790	63,760	79,790	78,610	77,420	76,240
7,000	51,940	51,100	50,260	49,420	68,820	67,760	66,700	65,630	82,140	80,920	79,700	78,480
7,200	53,420	52,560	51,700	50,830	70,790	69,700	68,600	67,510	84,480	83,230	81,980	80,730
7,400	54,910	54,020	53,130	52,240	72,760	71,630	70,510	69,380	86,830	85,540	84,260	82,970
7,600	56,390	55,480	54,570	53,660	74,720	73,570	72,410	71,260	89,180	87,860	86,530	85,210
7,800	57,880	56,940	56,000	55,070	76,690	75,500	74,320	73,130	91,530	90,170	88,810	87,450
8,000	59,360	58,400	57,440	56,480	78,660	77,440	76,220	75,010	93,870	92,480	91,090	89,700
8,200	60,840	59,860	58,880	57,890	80,620	79,380	78,130	76,880	96,220	94,790	93,370	91,940
8,400	62,330	61,320	60,130	59,300	82,590	81,310	80,040	78,760	98,570	97,100	95,640	94,180
8,600	63,810	62,780	61,750	60,720	84,560	83,250	81,940	80,630	100,900	99,420	97,920	96,420
8,800	65,300	64,240	63,180	62,130	86,520	85,180	83,850	82,510	103,300	101,700	100,200	98,670
9,000	66,780	65,700	64,620	63,540	88,490	87,120	85,750	84,380	105,600	104,000	102,500	100,900
9,200	68,260	67,160	66,060	64,950	90,450	89,060	87,660	86,260	108,000	106,400	104,800	103,200
9,400	69,750	68,620	67,490	66,360	92,420	90,990	89,560	88,130	110,300	108,700	107,000	105,400
9,600	71,230	70,080	68,930	67,780	94,390	92,930	91,470	90,010	112,600	111,000	109,300	107,600
9,800	72,720	71,540	70,360	69,190	96,350	94,860	93,370	91,880	115,000	113,300	111,600	109,900
10,000	74,200	73,000	71,800	70,600	98,320	96,800	95,280	93,760	117,000	115,600	113,900	112,100
10,200	75,680	74,460	73,240	72,010	100,300	98,740	97,180	95,640	119,700	117,900	116,100	114,400
10,400	77,170	75,920	74,670	73,420	102,300	100,700	99,090	97,510	122,000	120,200	118,400	116,600
10,600	78,650	77,380	76,110	74,840	104,200	102,600	101,000	99,390	124,400	122,500	120,700	118,800
10,800	80,140	78,840	77,540	76,250	106,200	104,500	102,900	101,300	126,700	124,800	123,000	121,100
11,000	81,620	80,300	78,980	77,660	108,200	106,500	104,800	103,100	129,100	127,200	125,200	123,300
11,200	83,100	81,760	80,420	79,070	110,100	108,400	106,700	105,000	131,400	129,500	127,500	125,600
11,400	84,590	83,220	81,850	80,480	112,100	110,400	108,600	106,900	133,800	131,800	129,800	127,800
11,600	86,070	84,680	83,290	81,900	114,100	112,300	110,500	108,800	136,100	134,100	132,100	130,100
11,800	87,560	86,140	84,720	83,310	116,000	114,200	112,400	110,600	138,500	136,400	134,700	132,300
12,000	89,040	87,600	86,160	84,720	118,000	116,200	114,300	112,500	140,800	138,700	136,600	134,500
12,200	90,520	89,060	87,600	86,130	120,000	118,100	116,200	114,400	143,200	141,000	138,900	136,800
12,400	92,010	90,520	89,030	87,540	121,900	120,000	118,100	116,300	145,500	143,300	141,200	139,000
12,600	93,490	91,980	90,470	88,960	123,900	122,000	120,100	118,100	147,800	145,700	143,500	141,300
12,800	94,980	93,440	91,900	90,370	125,800	123,900	122,000	120,000	150,200	148,000	145,700	143,500
13,000	96,460	94,900	93,340	91,780	127,800	125,800	123,900	121,900	152,500	150,300	148,000	145,800

Note: For other information pertaining to weight and volume of 3½-in. drill pipe, see table P 425.240.350.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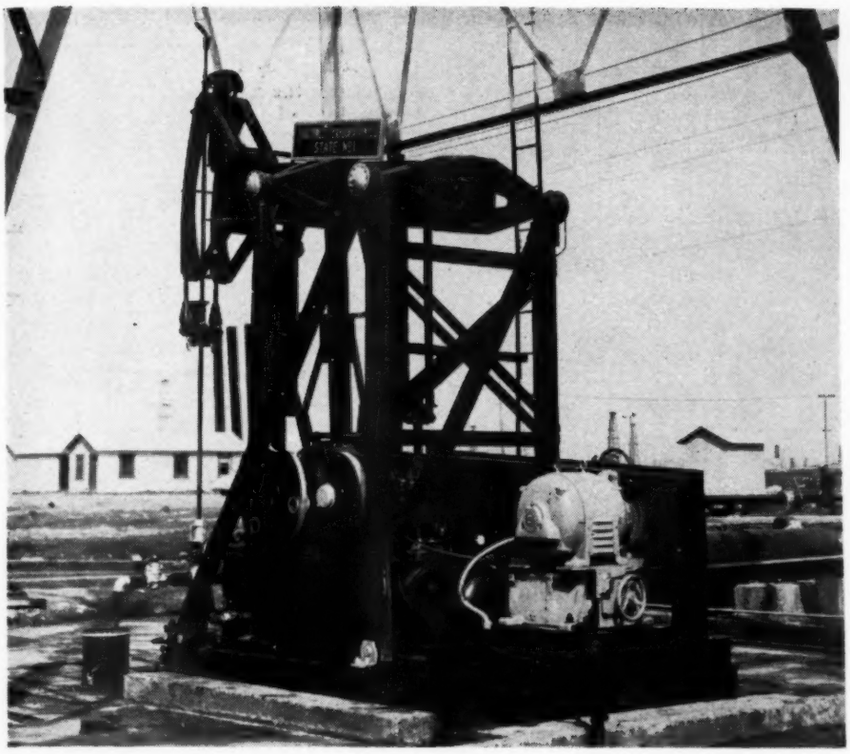


The pumping speed of this unit is readily changed by the hand-wheel shown to the rear of the sub-structure below the motor

A PETROLEUM ENGINEER EXCLUSIVE FEATURE

Continuous pumping at required speed eliminates proration shut-down—one derrick mounted on rails serves four wells

Variable Motor-Drive and Movable Derrick Provide Economy

By R. M. PYLES

Superintendent, Southwest Exploration Company

THE development of Southwest Exploration Company's State lease at Huntington Beach, California, has developed some interesting features. Upon completion, each well is put on the pump, the power for which is supplied by an electric induction motor that is readily adjusted by a handwheel to give any pumping speed necessary to meet production requirements without shutting down the well. The efficiency and economy in operation thus obtained is further enhanced by the arrangement of the surface production equipment, which takes full advantage of the straight-line location of the wells.

An 8⅝-in. water-string is cemented somewhere between 3700 and 4500 ft. (depending upon the measured depth of the well) and from 400 to 1000 ft. of liner set in the hole, which is drilled-in with oil. Upon completion, the drilling derrick, which is skidded to the next location, is replaced by a production derrick.

Only one 76-ft. production derrick is used for each group of four wells. At the bottom of each leg of the derrick is a roller that rides on a rail. Two rails are set in the concrete slab covering the derrick area and extend from one end of the well group to the other.

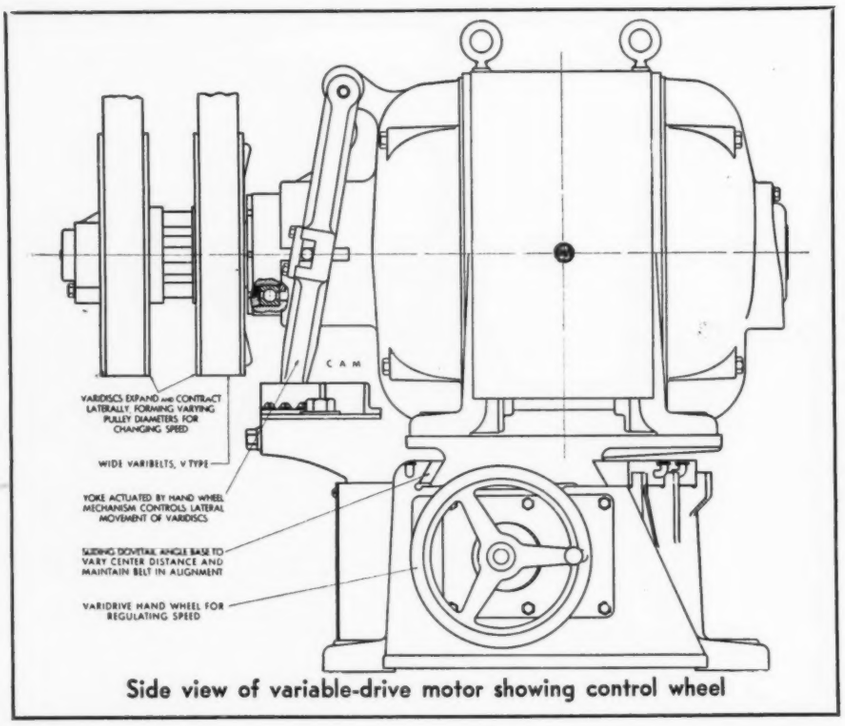
When servicing a well the derrick is anchored to the concrete by means of bolts, the legs resting on a steel base plate. When the derrick is to be used for servicing another well of its group, each leg is merely jacked up to remove the plate, the roller lowered onto the rail, and the derrick rolled over to the new location. It is there jacked up so that the base plate can be inserted and then lowered and bolted in place. Windows are provided in both sides of the derrick to permit passage over the pumping unit as the derrick is rolled from one location to another.

Mist from the ocean at Huntington Beach is very corrosive and necessitates the frequent repainting of steel derricks from the base to a height of 60 ft. By using the one production derrick for four wells this item of maintenance cost is reduced and the cost of three additional derricks eliminated.

Of particular importance in the op-

R. M. PYLES

worked on the first rotary rig used in the State of California—Was with the Associated Oil Company from 1909 to 1916, the first year in the Kern River field and after that at Taft, California—From 1916 to 1918 was with the Standard Oil Company of California—In 1918 went with Union Oil Company and was stationed at Santa Maria, California—From 1922 to 1930 was with the Shell Oil Company, after which he went with James A. Kammerdiner—From 1936 to 1938 was with the Hancock Oil Company.


VARIDISCS EXPAND AND CONTRACT LATERALLY, FORMING VARYING PULLEY DIAMETERS FOR CHANGING SPEED
WIDE VARIBELTS, V TYPE
YOKE ACTUATED BY HAND WHEEL MECHANISM CONTROLS LATERAL MOVEMENT OF VARIDISCS
SLIDING DOVETAIL ANGLE BASE TO VARY CENTER DISTANCE AND MAINTAIN BELT IN ALIGNMENT
VARIDRIVE HAND WHEEL FOR REGULATING SPEED
Side view of variable-drive motor showing control wheel

eration of the lease are the variable-drive motors* for driving the pumping units. The motors operate at all speeds between 13 and 26 s.p.m., speed being controlled by a handwheel that can be seen at the back of the motor assembly in one of the accompanying illustrations.

*This variable-drive motor, called Varidrive motor by the manufacturer, was designed by U. S. Electrical Motors, Inc., of Los Angeles, California.

The motor drives the pumping unit through two extra-wide V-belts. Each of the two pulleys attached to the motor shaft is constructed with one movable side. The base plate of the motor slides on the machined substructure by which it is supported. As the handwheel is turned to reduce speed the motor moves laterally and backward simultaneously, being guided by the dove-tail angle base plate machined at a slight angle from a line normal to the center line of the shaft. The yoke actuated by the handwheel mechanism causes the movable side of each pulley to move laterally, increasing the width of the V-shaped space between the levelled faces of the pulley. These widened spaces virtually drop the pulley grooves and allow the V-belt to slide farther down into the V-shaped space. This reduces the effective diameter of the pulley; thus the speed ratio is changed and the speed of the pumping unit reduced. The angle base causes the motor to move laterally, maintaining belt alignment. The backward movement of the motor takes up the slack in the V-belt.

Any desired pumping speed is thus obtained without either changing pulleys or performing any operation other than turning the handwheel. The rate of pumping is easily adjusted to meet requirements and the necessity for shutting-down the well eliminated. This variable feature is of particular advantage in the operation of the lease but from the viewpoint of proration is just as advantageous on any lease where constant, predetermined daily production over a definite period is desirable. Hazards accompanying shutdowns and the ill-effects of excessive pumping speed are eliminated.

Motors are of 7½ to 20 hp., according to depth and the amount of fluid being produced. Wells produce through 2½-in. tubing and are equipped with 1⅛- to 1¾-in. pumps.

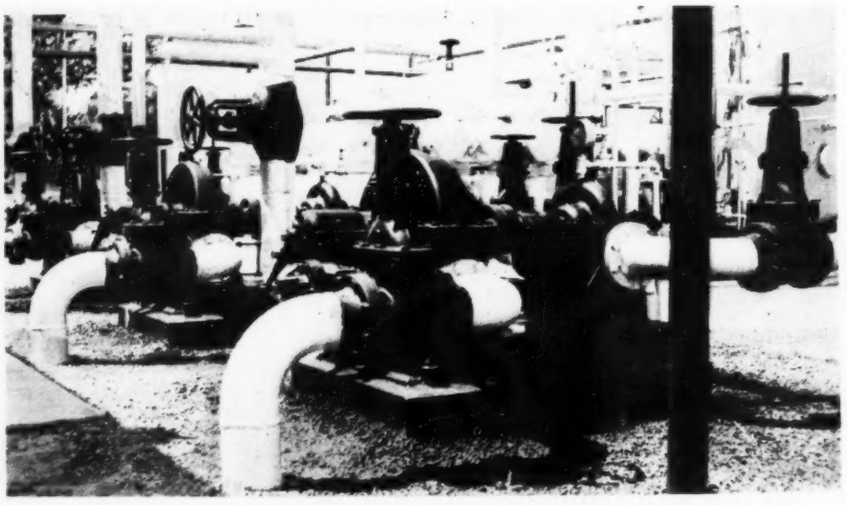
Distinct Valve Settings Aid Rapid Manipulation

By CHAS. C. LYNDE

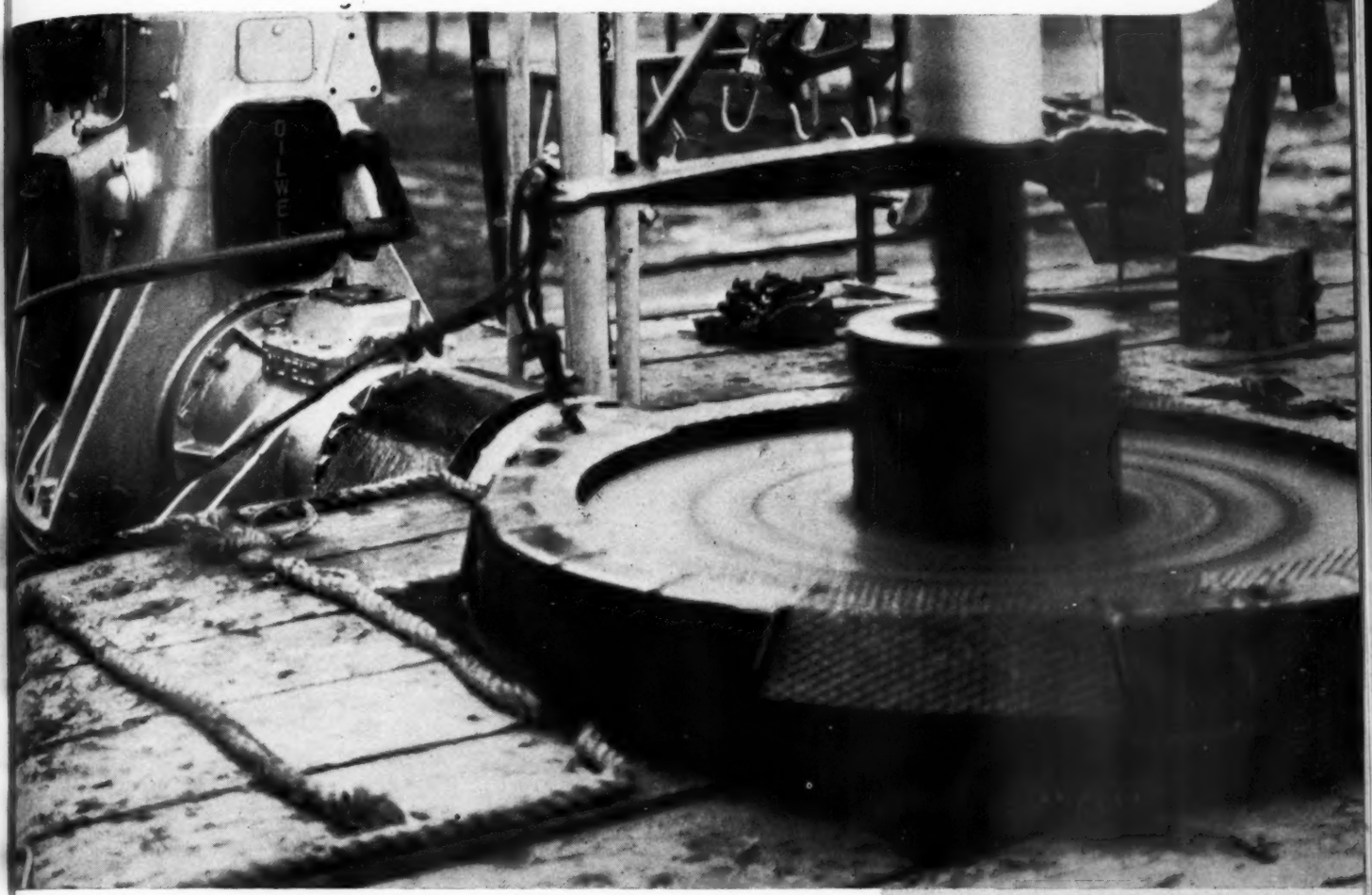
DIFFERENT types of valves and distinct means of setting are employed by one natural gasoline plant in East Texas to facilitate quick closing of the correct lines at night in the event a power failure plunges the yard into total darkness at the time an emergency shut-down must be made.

Discharge and suction valves on the centrifugal-pump units are set with hand-wheels horizontal. The two valves may be distinguished, however, in that discharge valves have rising stems and suction valves have non-rising stems.

Steam lines to the turbines driving the centrifugal pumps enter the turbines vertically from overhead. Each steam throttle valve is situated at head height from the ground having the hand-wheel set outward (away) from the pump unit, to be easily reached without entering between the operating units. As a further aid in locating the throttle valves in case of a power failure at night, the steam lines are painted white so they may be traced more readily.


Use of rising-stem gates on discharge lines of centrifugal pumps permits distant checking of flow layout and simplifies process routine

YEARS AHEAD OF THE FIELD!



THIS 27½-IN. OILBATH ROTARY is part of a two-spe "Oilwell" Rotary Drilling Unit, another development pi neered by "Oilwell" for faster and more efficient drillin

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Raoult's and Dalton's Laws Demonstrated in Vapor-Pressure Apparatus

Because of pressure phenomena involved in these laws, gasoline extraction by absorption requires less pressure than in the straight absorption process

By J. A. CAMPBELL
Consulting Natural Gas Engineer

A COMPREHENSIVE grasp of Raoult's and Dalton's laws is very helpful to anyone engaged in the extraction of natural gasoline from natural gas. They explain so much that seems complicated and involved to the layman. The laws themselves are rather simple and easily understood if properly explained.

Nearly everyone engaged in the extraction of natural gasoline from natural gas is conversant with the method of determining vapor pressure by means of the Reid vapor-pressure apparatus. This equipment gives us an excellent demonstration of the working of both of these laws.

When a volatile liquid is heated, it exhibits a tendency to vaporize. If the vapor above the liquid is confined, pressure is developed that tends to stop the evaporation. When the evaporation ceases, this pressure is equal to the vaporizing tendency. The vaporizing tendency is important because it is the cause of gas lock in a motor if the fuel is too volatile. Actually the vapor pressure is measured, but as the two are equal, the vaporizing tendency for the given fuel at the given temperature is thus made known.

Of course, technically, evaporation does not cease. When equilibrium is reached, the rates of condensation and evaporation balance. The molecules are constantly in motion, passing from liquid to vapor and back again. At constant temperature, there is no change in the volume of liquid or of vapor, hence no change in the vapor pressure and for practicable purposes the evaporation may be regarded as having ceased.

Dalton's law states that the vapor pressure resulting from a mixture of vapor is the sum of the partial pressures of those vapors. Stated differently, Dalton's law says that the amount of vapor that can exist in a given space depends solely upon the temperature and is the same whether that space be vacuous or occupied by another gas. For example: Suppose a sample of gasoline is tested in a Reid bomb at a bath temperature of 100° and a reading of 21 lb. obtained. This pressure-gauge reading is the gauge pressure of the gas-air mixture in the bomb and is a measure of the vaporizing tendency of the gasoline in the presence of air. If the upper chamber had been completely evacuated to eliminate all air, the pressure would be 14.73 lb. less or 6.27 lb.

J. A. CAMPBELL

entered employ of Union Oil Company in 1917—Occupied at various times the positions of research engineer, construction engineer, superintendent of construction, design engineer, and engineer of gas plants—In 1923 accepted the position of chief engineer of the Lomita Gasoline Company, Long Beach, California, acquiring an interest in the company—In 1924 formed the J. A. Campbell Company and engaged in the design and construction of absorption plants for the next eight years—In 1932 retired from the contracting business to enter field of research and development—At the present time, in addition to being vice-president and chief engineer of the Lomita Gasoline Company, he is president of J. A. Campbell Company, manufacturing and development engineers, engages in natural gas consulting work, and is an officer or director in five other companies engaged in various activities in southern California—Is a graduate of Ogden College and Yale University.

Assume the upper portion of the bomb to contain a piston of perfect fit, the gauge take-off to be from the connection between the two bombs, and the lower chamber to be made of glass. Now, assuming a gauge reading of 21 lb. for a certain position of the piston, if the piston is moved to reduce the vapor space, the vapor pressure is increased and the equilibrium is disturbed if the temperature remains constant. A portion of the gasoline will condense, due to the increased pressure. This increase in the volume of liquid may be observed in the lower chamber. But what happens to the pressure? This unbalanced condition cannot be maintained. As the gasoline vapor changes back into liquid, it shrinks materially in volume and the pressure declines to something above 21 lb. There is less vapor space so there is a greater crowding of the vapor remaining, hence a greater vapor pressure and a greater vaporizing tendency. There will, of course, be a release of heat inside the bomb because of the latent heat liberated by the change of state from vapor to liquid. This will be dissipated by maintaining a constant bath temperature. Reverse the operation and move the piston up in the upper chamber to increase the vapor space. This will lower the vapor pressure causing further evaporation until the pressure is something less than 21 lb. because of the less-crowded condition in the vapor space. The heat flow this time will be reversed and will be from the bath into the bomb. There will be a reduction of the liquid volume in the glass chamber. In each case equilibrium is restored.

Suppose a vapor-pressure test is conducted using the standard Reid apparatus in the regulation manner on a sample of natural gasoline resulting in a reading of 21 lb. The test is repeated, filling the lower chamber only one-half full. The reading will be lower because of the increased space and the lessened amount of liquid. How much

lower will depend on the varying proportion of the different constituents. For example, one test conducted by the writer showed 1.4 lb. lower. Consistent results depend upon a constant relationship between the volume of liquid and the vapor space. That is why it is important to see that the volume of each chamber complies with specifications.

But why is this? It has been stated that the vapor pressure is the same as the vaporizing tendency and the above two tests were made using the same material and the same intensity of heat in the bath. Why should not the gasoline in the second test continue to evaporate until it has developed a pressure as great as in the first test? This would be the case with a pure substance of constant boiling point such as ether. Such a liquid, under a constant temperature, would continue to evaporate until the entire space was filled by vapor at a pressure sufficient to overcome the vaporizing tendency that has a fixed value regardless of the size of the vapor space. The limit to the size of the vapor space is a size just large enough so that we do not evaporate the last drop of liquid.

Natural gasoline is a very complex substance. It is a mixture of various components each of which, in its pure state, has a different vapor pressure. When evaporation starts in the gasoline chamber of the Reid apparatus, the more volatile constituents, such as propane, tend to leave the liquid. There may even be a trace of dissolved ethane and methane. These have high vapor pressures and as they leave the liquid, the vaporizing tendency of the remaining liquid is less, consequently the remaining liquid is less volatile and it is the evaporation of these heavier less-volatile fractions that increases the vapor pressure.

A knowledge of steam engineering tells us that if water is heated to a certain temperature, steam is developed at a certain pressure regardless of the size of the boiler or the relationship between the volume of water and the vapor space. The steam header could be a mile long but if properly insulated to prevent loss of heat and not opened to flow, the same pressure would prevail at its end as in the boiler. Water is a liquid of constant boiling point and the same degree of heat will produce the same vaporizing tendency after prolonged evaporation. Such is not the case with a mixture of components of different boiling points such as natural gasoline and that is why, to make comparisons of different gasolines, so far as their relative volatility is concerned, a common standard must be agreed upon.

This will explain why, when the piston is forced downward, and the pressure is increased, the vaporizing tendency is increased. Through compression, certain volatile fractions were liquefied that had evaporated from the liquid and by returning these light fractions to the liquid, the liquid became more volatile, which is another way of saying its vaporizing tendency was increased.

Analyze these results in the light of Dalton's law. Dalton's law states that the total pressure resulting from a mixture of vapors is the sum of the partial pressures of those vapors. In the larger space, the total pressure was less. This means then that the sum of the partial pressures was less. Does it mean that all partial pressures are proportionately less or that some are decreased more than others? Strange as it may seem, it is the partial pressure of the more volatile fractions that is lower. Before going into the explanation of this, let us state and explain Raoult's law as follows: The introduction of a solute into a volatile liquid lowers the partial pressure of the liquid if the solute is volatile. This law helps us to understand why a gasoline having a vapor pressure of 21 lb. may contain components that have much higher vapor pressures in their pure state. If the vapor pressures of all the components that enter into 21-lb. natural gasoline were added, a figure well over 200 lb. would be obtained. Butane, for example, which can be incorporated into natural gasoline of 21-lb. vapor pressure to 28 percent of its volume, has a vapor pressure of 52 lb. When these components are mixed there is a reduction of all their vapor pressures, hence their vaporizing tendencies. Expressed simply, "The heavier fractions hold the light fractions down." Actually the light fractions also help to "hold the heavier fractions down." In equilibrium the partial pressure of each component balances with the vaporizing tendency of the component in the liquid.

Returning to the case in point, as the heat goes into the liquid and the lighter, more volatile fractions leave the liquid and go into vapor, they do so because the vaporizing tendency is greater than the partial vapor pressure of their components and they will continue to evaporate until equilibrium is reached; but as more and more of any component leaves the liquid, its vaporizing tendency in the liquid is becoming less and less until it balances with the vapor pressure of this component in the vapor above the liquid. All of the component cannot be evaporated from the mixture if the vapor from this component is permitted to build-up a pressure on the surface of the liquid. Suppose a very small amount of propane is present in the gasoline. This amount will reach equilibrium in a given vapor space. If, however, the space is increased, there may not be enough propane to fill the added space with a proportionate share of its vapor. Also, increasing the space lowers the pressure of all constituents, and as the concentration of heavier fractions in the liquid is greater, their evaporating tendency is greater because the vaporizing tendency of propane has been lessened by the evaporation of propane. These other fractions, such as butane and iso-butane, exist in much larger proportions than the propane and are capable of evaporating in sufficient amount to build-up their share of the total pressure but, having lower vapor pressure, they cannot make up the deficiency in pressure caused by a lack of propane.

When extracting gasoline by the compression method, the total pressure in the condensers must be sufficiently high so that the partial pressure of any one component is greater than the vaporizing tendency of that component in the condensate. This is better explained by an example. Assume that a gas contains 1.5 percent of pure hexane vapor and that this is the only gasoline fraction in the gas. To condense hexane at a temperature of, let us say, 80°F. in the condensers by pressure alone, this pressure must be great enough to overcome the vapor pressure of hexane, 2.9 lb., at 80°F. The hexane vapor constitutes only 1.5 percent of the total gas so the total pressure must be an amount 1.5 percent of which equals 2.9 lb., or 193 lb. per sq. in. As soon as condensation starts, the percentage of hexane vapor in the gas becomes less and if enough hexane is condensed to reduce its content to 1 percent, it will require 100 times 2.9 lb., or 290 lb., to obtain further condensation of hexane and increasingly higher pressures or lower temperatures will be required to liquefy a greater amount.

In the above example it was necessary to overcome the full vapor pressure of hexane. If, however, the gas had been brought into intimate contact with cold absorption oil, it would have been necessary to overcome only the partial pressure of hexane in the oil, which under Raoult's law would have been very much reduced. By the absorption method, because of Raoult's law, the same amount of stripping can be accomplished using very much lower pressures than by straight compression. After the gasoline vapor becomes absorbed in the oil, it is in the liquid phase, mixed with the oil. The

latter must be heated to develop the vaporizing tendency of the gasoline so it will separate from the oil as a vapor that can be condensed by cooling.

The effect of vapor-pressure lowering, according to Raoult's law, is very pronounced in mixtures of natural gasoline and absorption oil if the percentage of the former is kept low. In a recent article[1], the writer described a modified form of the Reid vapor-pressure apparatus that he uses to demonstrate the application of Dalton's and Raoult's law. Using one lower chamber, the vapor pressure of a large sample of gasoline was determined to be 21.4 lb. Mixing equal amounts of this gasoline and 37° A.P.I. kerosene distillate, the absorption oil used in California, a test in one of the lower chambers resulted in a reading of 15.8 lb. Next, in a test of a quantity of the same gasoline equal to a volume of 5 percent of the volumetric contents of the lower chamber a vapor pressure of 9.2 lb. was recorded. This, of course, would be much lower than the original reading because of the greatly increased vapor space and the reduced quantity of gasoline. Next, one chamber was filled with 5 percent of its volume of this gasoline and the other, which is the same size, was filled with 95 percent of its volume of the absorption oil. Keeping the valve closed between the oil chamber and the air chamber, the vapor pressure of the gasoline was determined to be 9.6 lb. Next, the valve was opened and the apparatus inverted several times, permitting the gasoline, oil, air, and gasoline vapors to mix thoroughly. The apparatus was submerged in the 100° bath and the inverting and shaking operation repeated twice. When equilibrium was attained, the pressure gauge recorded a vacuum of 1 in. of mercury. This might seem surprising but it is easily explained by the fact that some of the volatile fractions from our small sample evaporated into the 95 percent vacant space above the liquid in the gasoline chamber, expelling some of the air. The oil at 100°F. was capable of liquefying a volume of vapor greater than that which evaporated from the gasoline after the apparatus was made tight and so, in addition to that amount, absorbed some of the vapor that existed in the gasoline chamber before the air chamber was screwed on. As a result, at the end of the test, less volume of air-gasoline-vapor mixture was present in the fixed space and hence less pressure was exerted. Beginning with atmospheric pressure before connecting the two chambers, less than atmospheric pressure was recorded at the end of the test.

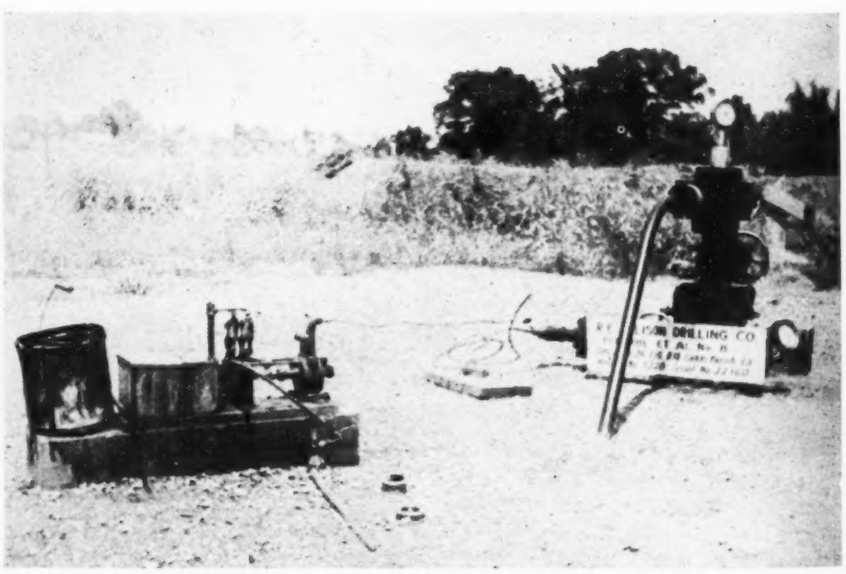
As a check on these results, next the gasoline chamber was tightly stoppered and chilled to a very low temperature by evaporating liquid butane. The stoppering precaution was to prevent any butane vapor entering the chamber. Next, the sample of likewise precooled gasoline was admitted to the bottom of the chamber through a similarly chilled pipette. This chilling to a temperature so much lower than that afforded by the usual method of ice cooling, made it reasonably certain that very little of the sample evaporated into the space above the liquid. The reading was 1.2 lb., showing a very much lower pressure than the 9.6 lb. of the gasoline. The comparison, however, should really be made with the 21.4 lb. obtained when the lower chamber was full of gasoline because the oil and gasoline completely filled one chamber. The vapor pressure of the oil itself at 100 deg., is only 1.5 millimeters, which is negligible in comparison.

These tests demonstrate the effectiveness of absorption oil in reducing the vaporizing tendency of the gasoline when the two are mixed in the proportion of 95 percent and 5 percent, respectively. This percentage was chosen because it is one often used in gasoline plant practice.

[1] "Special Vapor-Pressure Bomb for Demonstration of Vapor-Liquid Relationships," by J. A. Campbell, *The Petroleum Engineer*, Feb., 1939.

Small Unit Pumps Treating Fluid Into Flow Line at Well In Shreveport Field

Water contained in the oil produced from the Shreveport field, Caddo Parish, Louisiana, has necessitated various treating methods in order to clean-up the oil. One device, shown in the accompanying photograph, is a lubricator powered by a small motor or engine driven by the energy of high-pressure gas taken from the casing of the well through ¼-in. copper tubing. The tank on the pump block contains the treating chemical, which is injected under pressure into the flow line continuously.



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Oil-Well Cements—Chemical Composition and Sensitiveness to Additions of Water

PETROLEUM ENGINEER EXCLUSIVE FEATURE

Studies show high-iron cements are sensitive to increases of water content —high-alumina cements are relatively insensitive to water changes

By S. L. MEYERS
Chief Chemist, Southwestern Portland Cement Company

PROFESSOR Solacolu at the Technological Laboratory of the Technical College of Bucharest has made a study of the effect of large additions of water on the strength of different portland cements. At the present time cements for oil-well use are undergoing rapid changes in composition and properties in the United States and the direction of change appears to be toward a cement of low-water-requirement, particularly at elevated temperatures. Professor Solacolu's study of water sensitiveness of cements presents a new angle to the problem of producing a desirable oil-well cement and his work in combination with American studies may lead to some practicable advancement so a condensed outline of his results are given here.

The object of the research was to show the relationship between the chemical composition of the cements and their sensitiveness to large additions of water. The quality, or properties, of a cement also depend upon physical factors such as nature of raw materials, its fineness, the degree of burning, fineness of clinker grind, etc. The cements used in this research were prepared having the physical factors as uniform as possible so that the chemical composition alone would determine any variation in cement properties.

The raw material mixes were designed to give a constant lime saturation of 0.98 using Lea and Parker's formula:

$$K = 100 \times \frac{CaO}{2.8\,SiO_2 + 1.18\,Al_2O_3 + 0.65\,Fe_2O_3}$$

Variations in the mix occur between the silica, alumina, and iron oxide. Their relationships are represented by ratios or moduli:

*The lime saturation ratio K does not mean that all of the clinker compounds are saturated with lime, but it indicates the limit of practical combination during the burning process.

S. L. MEYERS

after attending the University of California joined the staff of the Southwestern Portland Cement Company as a chemist at its California plant—That was in 1919—In 1928 he was transferred to El Paso, Texas, as chief chemist to do research work to coordinate the properties of the company's oil-well cement with the needs of the oil operator—At present he is working on the problem of the best grading of cement particles in cement grouts—He is a member of the American Association of Engineers and of the American Concrete Institute.

$$\text{Silica modulus} = Ms = \frac{SiO_2}{Al_2O_3 - Fe_2O_3}$$

$$\text{Alumina modulus} = Ma = \frac{Al_2O_3}{Fe_2O_3}$$

In the accompanying figures the silica and alumina moduli of each cement are referred to a system of rectilinear coördinates. Each point in the diagram represents a cement having definite moduli.

All raw materials were burned without contamination on platinum plates to a free lime content of 0.1 to 0.5 percent. The resulting clinkers mixed with 3 percent gypsum were ground to 5 percent residue on a sieve of 4900 meshes per sq. cm. (about No. 180 sieve).

The neat cement-water pastes were tested for strength at water-cement ratios of 0.3 and 0.5, which is similar to the methods used in the United States in testing oil-well cements.

The size and molding of test pieces followed the miniature methods of Kuhl and instead of compression and

TABLE I

Position on figure, letter	Silica modulus, SiO_2 / Al_2O_3-Fe_2O_3	Alumina modulus Al_2O_3 / Fe_2O_3	K	Corresponding compound composition percentage: Tetracalcium alumino ferrite ($4CaO.Al_2O_3.Fe_2O_3$)	Tricalcium aluminate ($3CaO.Al_2O_3$)	Tricalcium silicate ($3CaO.SiO_2$)	Dicalcium silicate ($2CaO.SiO_2$)	Dicalcium ferrite ($2CaO.Fe_2O_3$)
A	2.0	0.2	.98	8.0	0.0	63.5	10.0	9.9
B	1.3	0.64	.98	25.8	0.0	56.8	9.1	...
C	2.0	0.64	.98	18.8	0.0	63.9	9.1	...
D	2.9	0.64	.98	13.6	0.0	69.0	9.0	...
E	1.3	1.4	.98	17.3	11.5	47.1	15.8	...
F	2.0	1.4	.98	12.5	8.3	57.0	13.7	...
G	1.3	2.0	.98	13.8	16.4	43.6	17.9	...
H	2.2	2.0	.98	9.2	10.9	56.2	15.2	...
I	2.9	2.0	.98	7.3	8.7	61.5	14.1	...
J	2.2	2.7	.98	7.5	13.4	54.1	16.5	...
X	1.8	4.2	.86	17.4	0.0	34.8	37.8	6.0
Y	2.2	0.56	.84	17.9	0.0	42.3	32.0	1.5

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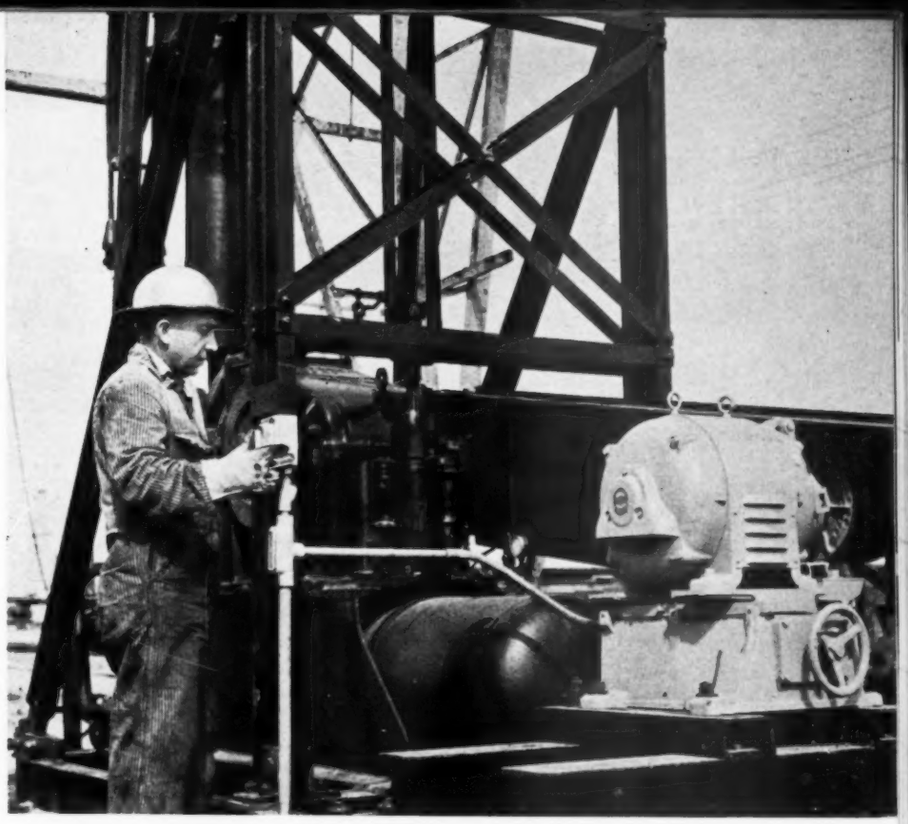
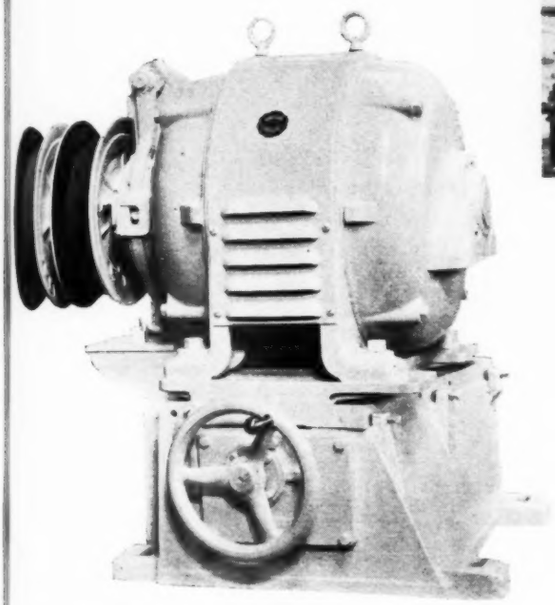


Pumping unit at Huntington Beach using U. S. Varidrive, one of many such units earning extra production



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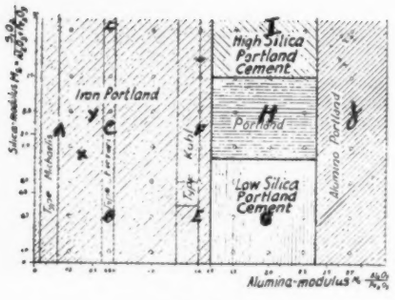


Fig. 1

tension, the specimens were tested in "bending-tensile" tests, known in this country as beam tests and modulus of rupture tests.

Fig. 1 shows the range of cement composition from Ms of 0 to 3.0 and Ma of 0 to 3.0 for all lime saturations of 0.98.

Table 1 gives the compound composition of cements corresponding to the positions in Fig. 1 marked by letters of the alphabet. X and Y are two sulphate-resistant cements manufactured in the Southwest primarily for oil-well use at high temperatures. They can be located in this diagram according to Ms and Ma, but their lime saturation ratio is lower than the series of cement in this research.

Fig. 2 shows that in the range of normal consistency the water requirement decreases with decreases in both moduli. This is in harmony with the trend towards high-iron oil-well cements in American practice.

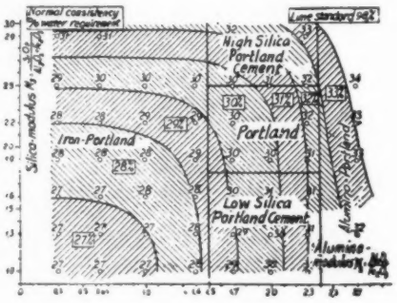


Fig. 2

Fig. 3 shows final setting times in minutes. Cements situated centrally in the diagram with medium moduli generally are slow setting whereas those in extreme positions are quick-setting. These tests were made at 20°C. (70°F.). At higher temperatures the cements in the lower lefthand corner of the diagram might not be so quick-setting in comparison with those located more centrally.

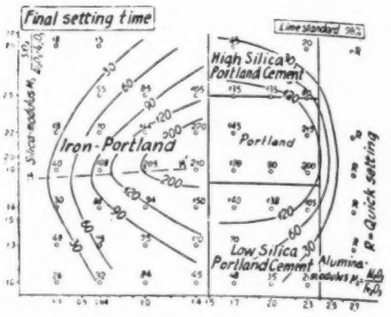


Fig. 3

Figs. 4 and 5 give the bending (modulus of rupture) strengths with water-cement ratios of 0.3 and 0.5 at different points in kg. per sq. cm.; to obtain lb. per sq. in. multiply by 14.223.

Fig. 6 utilizes the results of Fig. 4 and Fig. 5 to obtain the sensitiveness

TABLE 2

Influence of Raw Material and Composition on the Sensitiveness of Cement to Large Additions of Water

Approximate compound composition				Modulus composition			Raw material	Bending strength, lb. per sq. in., 21 days		Water sensitiveness
								Water-cement factor		
Tetracalcium alumino ferrite	Tricalcium aluminate	Tricalcium silicate	Dicalcium silicate	Silica modulus M_S	Alumina modulus M_A	Lime standard K_S		W=0.3	W=0.5	(Loss of strength due to increase of w/c divided by strength at w/c=0.3)
25.75	0.0	56.8	9.1	1.3	0.64	98	A	420	92	78.0
							B	549	92	83.0
17.3	11.5	47.1	15.8	1.3	1.4	98	A	575	142	75.0
							B	494	145	70.0
14.9	15.0	45.2	17.0	1.3	1.7	98	A	438	171	60.0
							B	410	173	57.0
22.1	0.0	60.5	9.1	1.6	0.64	98	A	567	122	78.0
							B	501	107	78.0
11.9	14.0	49.0	16.7	1.6	2.0	98	A	400	159	60.0
							B	400	178	55.0
12.7	8.8	56.1	13.9	1.9	1.4	98	A	523	233	56.0
							B	464	171	63.0
9.2	13.6	52.0	16.6	1.9	2.3	98	A	408	240	42.0
							B	441	227	48.0
11.7	7.7	59.2	13.2	2.2	1.4	98	A	484	206	57.0
							B	468	199	57.0
9.3	8.6	60.0	13.8	2.5	1.7	98	A	410	250	39.0
							B	371	245	34.0
6.5	10.0	60.5	14.8	2.9	2.3	98	A	400	233	41.0
							B	450	233	48.0

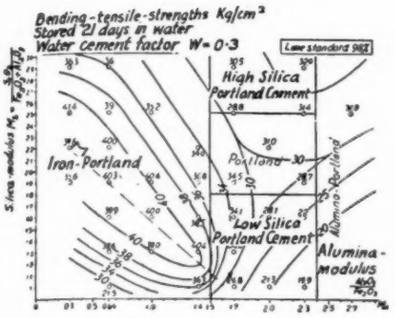


Fig. 4

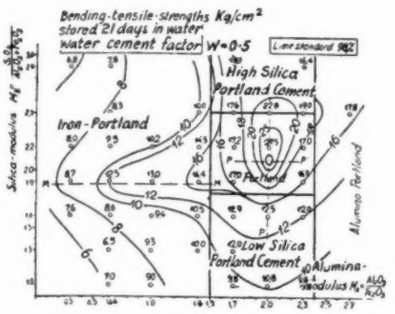


Fig. 5

of the cements to large additions of water; the percent figures are the loss in strength caused by changing from w/c = 0.3 to w/c = 0.5, divided by the strength at w/c = 0.3.

The high-iron cements are relatively sensitive to increases of water content, whereas the high-alumina cements are relatively insensitive to water changes.

The practical application of this is that if varying amounts of mixing water are used in cementing a well, less hazard is involved using a cement having Ms = 2.3 and Ma = 2.0 than in using a cement having moduli in the left half of the diagram.

Special oil-well cements having high alumina content were manufactured in Roumania but were abandoned for moderately high alumina cements. Three of the present oil-well cements now manufactured in that country have the following compositions:

Cement Symbol	*"U"*	*"S"*	*"A"*
Alumina modulus, Ma	2.03 to 2.16	1.8 to 1.9	1.75
Silica modulus, Ms	2.01 to 2.02	1.95 to 2.1	2.7

Cement "U" and "S" attain great strengths at a w/c ratio of 0.6.

Table 2 indicates that differences in raw materials (A and B) have a slight effect on water sensitiveness, but that the silica and alumina moduli are more important.

Table 3 and Fig. 7 show the effect of some common electrolytes on water sensitiveness. Aluminum chloride concentration of 0.5 percent and calcium chloride concentration of 3.5 percent act favorably and decrease the water sensitiveness. Calcium chloride in amounts from 0.5 to 1.5 percent acts unfavorably; this is about the amount used in American practice (sp. gr. = 1.015).

Many Roumanian oil wells are 5000 to 8000 ft. in depth and a few are over 10,000 ft., so the effect of high temperature on cement must be a factor. This has not been considered in the present research. It would be of interest to repeat the tests under the following conditions:

At higher temperatures.

With varying fineness.

With varying lime saturation (ratio K).

The need of a cement remaining

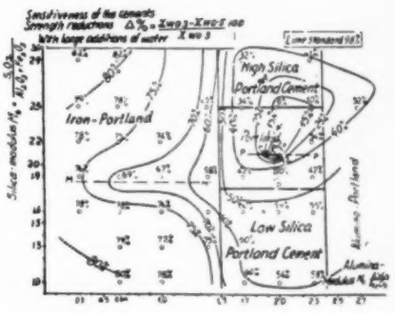


Fig. 6

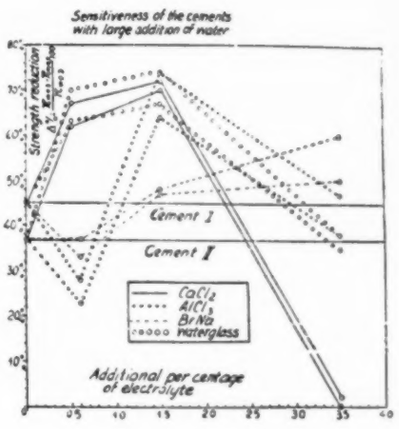


Fig. 7

fluid long enough to permit its placement satisfactorily in deep high-temperature wells gave rise to the "ice cream freezer" apparatus of the Standard Oil Company. This instrument in turn has helped to develop cements having a low viscosity under the conditions of test simulating the actual conditions of placing oil-well cement. This lowered viscosity has usually been obtained by decreasing the ratio of Al_2O_3 to Fe_2O_3, by decreasing the surface area, or both.

As higher well temperatures are encountered the property of low viscosity having satisfactory strength becomes increasingly important, but other factors such as resistance to permeability, ability to bond to the well-wall, plastic flow or extensibility under stress, ability to remain dispersed and settle from thin, water-diluted grouts, and water sensitiveness are involved, and the factors most important will depend upon the conditions in the well.

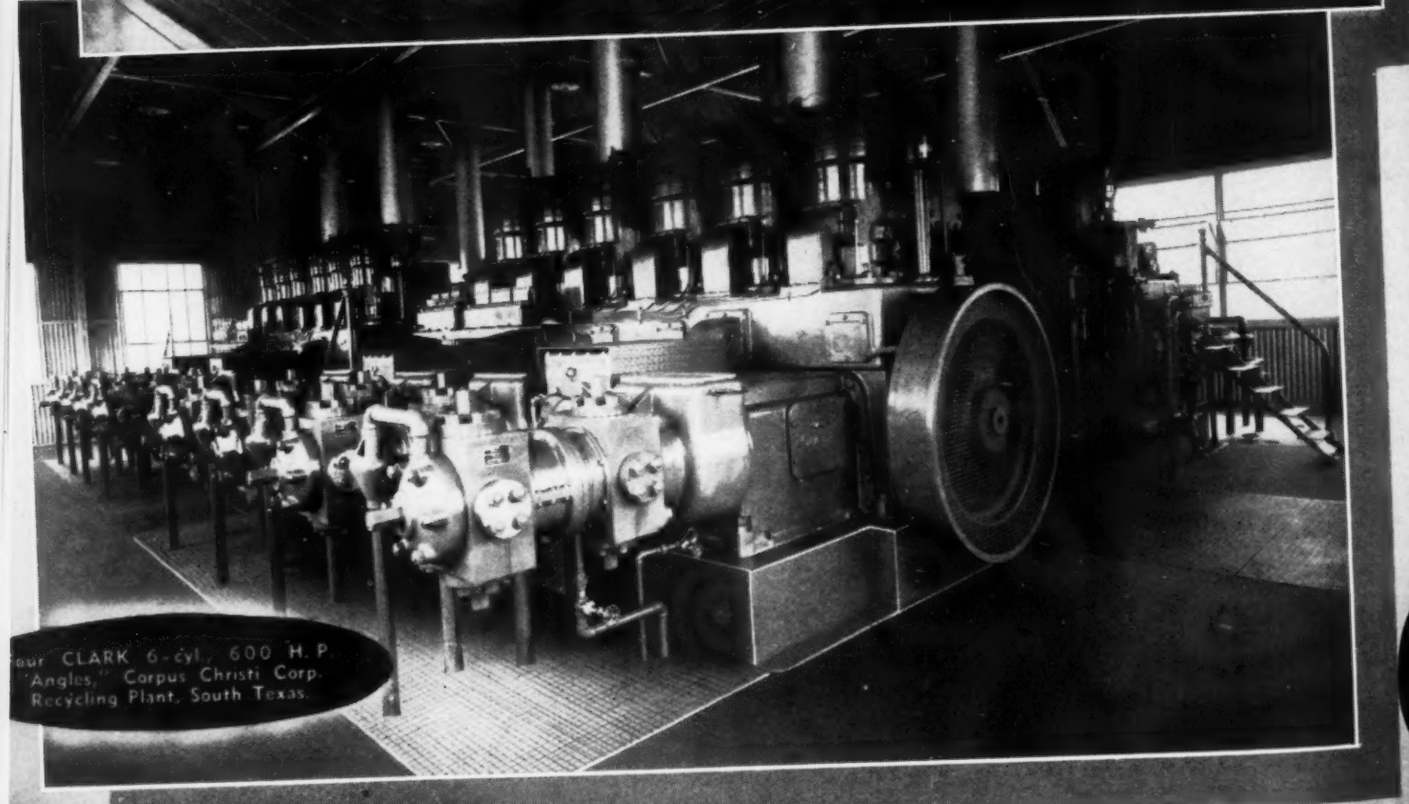
TABLE 3

Influence of Additions of Electrolyte on the Sensitiveness of Cement to Large Additions of Water

Electrolyte, percent		0	0.5	1.5	3.5
		Loss of strength with addition of electrolyte at w/c 0.5 compared to plain w/c 0.3, percent			
$CaCl_2$	Cement I	37	67	72	0
$CaCl_2$	Cement II	45	72	70	2
$AlCl_2$	Cement I	37	25	74	47
$AlCl_2$	Cement II	45	23	64	38
NaBr	Cement I	37	37	48	60
NaBr	Cement II	45	33	47	50
Waterglass	Cement I	37	70	74	38
Waterglass	Cement II	45	63	67	35
$MgCl_2$	Cement I	37	60	62	85
$MgCl_2$	Cement II	45	64	60	75

100,000 H.P.

Three CLARK 4-cyl., 400 H.P. "Angles," Stanolind Seaboard Luby Gasoline Plant, Texas.



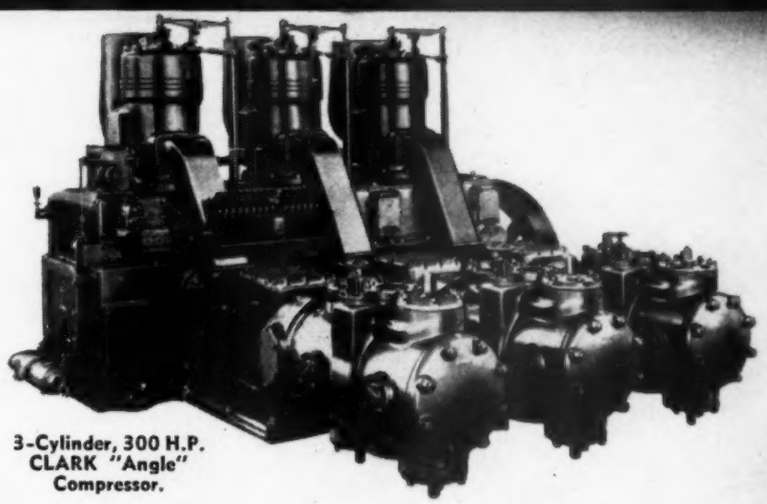
Four CLARK 6-cyl., 600 H.P. "Angles," Corpus Christi Corp. Recycling Plant, South Texas.

...in 3 Years

...IS SALES RECORD OF CLARK "ANGLES"

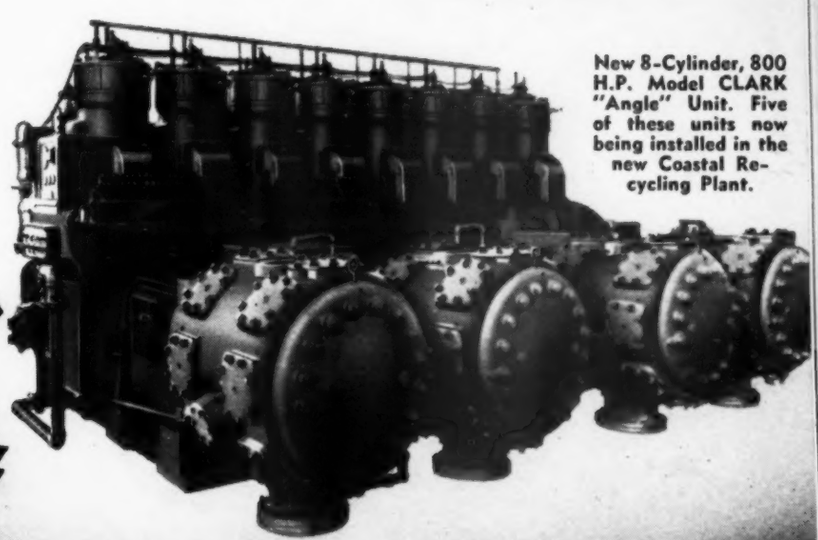
The month of September is particularly significant to the CLARK organization because it marks the third anniversary of the shipment of the first CLARK "Angle" Compressor units from the factory. These initial orders covered some 300-H.P. units which were shipped to California and Texas. Since then the line has been developed so that eight models ranging from 165 H.P. to 800 H.P. are now available in gas engine driven units. In addition to this, the full Diesel unit has been developed in sizes from 150 to 600 H.P.

During these 3 years, approximately 300 units, totaling over 100,000 horsepower have moved from the Clark factory into the oil fields of the world. That the unit is increasing in popularity and earning an enviable reputation in the field is attested by the fact that during the month of July, 1939, seven different petroleum companies gave us orders for 28 units totaling 16,650 H.P. The greater part of these orders were repeat orders from satisfied users. We are naturally deeply gratified by such conclusive evidence that our efforts to combine the best of engineering knowledge and design with the finest of material and workmanship, in order to produce the best compressor unit that can be built,—is appreciated by our many friends in the petroleum industry.



3-Cylinder, 300 H.P. CLARK "Angle" Compressor.

6-Cylinder, 600 H.P. CLARK "Angle" Compressor.



New 8-Cylinder, 800 H.P. Model CLARK "Angle" Unit. Five of these units now being installed in the new Coastal Recycling Plant.

CLARK BROS CO. . . Olean, New York, U.S.A.

Export Office: 30 Rockefeller Plaza, New York. Domestic Sales Offices and Warehouses: Tulsa, Okla.; Houston, Texas; Chicago, Ill.; Boston, Mass. (131 Clarendon St.) West Coast Office: Smith-Booth-Usher Co., Los Angeles, Cal. Foreign Offices: 72 Turnmill St., E. C. 1, London; 4 Str. Gen. Poetas, Bucharest, Roumania.

CLARK

The Development of Anti-Knock Motor Fuel

Improvements in motor fuel have contributed to advancements in engine design — Air-fuel ratios, spark timing, and other adjustments have marked effect on detonation

Part 1

By A. W. TRUSTY, Chief Chemist, Arkansas Fuel Oil Company

IN the last decade rapid strides have been witnessed in the development of the automobile engine, and in the same period a corresponding change has occurred in the characteristics of motor fuel. The automobile manufacturer in gaining improvements in engine efficiency has often been dependent upon the refiner's ability to improve the quality of the fuel. Thus the improvements in engines and fuels have advanced together in a sort of cut-and-try method. It is encouraging to note recent evidences of a closer understanding and coöperation between automobile manufacturers and refiners that should result in benefit to both industries.

Of all the factors limiting engine efficiency, knocking or detonation is by far the most important. The noise to which the name "knock" has been applied may be compared to that produced by a sharp ringing blow upon the metal of the engine cylinder. Earlier it was believed that the noise was due to contact between worn engine parts, but later investigation has developed the theory that the knock is due to a wave of high-pressure gas striking the walls and head of the combustion chamber.

The distinction between pre-ignition and knocking should be noted. In the automobile engine, combustion is initiated by an electric arc timed to occur at a definite instant toward the end of the compression stroke. The correct timing varies according to the engine speed and certain other factors, but ignition should never occur prior to the spark. If pre-ignition does occur because of overheated spark-plug points or particles of incandescent carbon, it results in violent knocking and the development of excessive pressure before the end of the compression, and the engine may cease running. Knocking, however, happens after the passage of the spark, while the combustion and subsequent expansion of the gas are proceeding; if it is not too violent, it may persist for short periods without harm to the engine. On the other hand, violent knocking soon leads to overheating and may develop into pre-ignition. Pre-ignition and knocking, nevertheless, are considered as quite separate phenomena. Knocking follows, but pre-ignition precedes, the ignition spark.

A. W. TRUSTY

graduated from Mississippi College in 1925 with a bachelor's degree — Joined staff of Lion Oil Refining Company as chemist and that same year (1925) transferred his affiliation to the Louisiana Oil Refining Company—In 1928 he became chief chemist of that company, which position he retained when later it became the Arkansas Fuel Oil Company — Resides in Shreveport, Louisiana.

In general, the higher the compression ratio in an engine, the greater will be the detonation using any specific fuel. The increase in compression pressure of the automobile engine has depended, therefore, upon the ability to increase the anti-knock quality of the fuel. The anti-knock property of a gasoline is evaluated by an arbitrary octane-number scale, ranging from 0 to 100, or even higher. Two pure hydrocarbons, iso-octane and n-heptane, have been adopted as standard reference fuels. Iso-octane (2, 2, 4 trimethyl pentane) does not detonate and, therefore, is given the value of 100 octane-number. N-heptane, a violent knocker, is given the value of zero octane-number. The octane number of a gasoline, then, may be determined by measuring the percent of iso-octane present in the blend of iso-octane and heptane that will match the anti-knock value of the "unknown" fuel in a special test engine.

The knock-testing engine has had an interesting history. From the earlier development and the many different engines, different operating conditions, and different reference fuels that were proposed and used for a time, the present method, although far from perfected, has emerged as an important step toward uniform testing procedure.

One of the first test engines used by many refiners was supplied by the Ethyl Gasoline Corporation. Other engines were used, however, and in 1928 a move was made to standardize methods of knock-rating measurement. Results obtained by different observers on different engines were rarely comparable; wide discrepancies often were observed, and it was recognized that the adoption of standard test equipment and a standard test method was necessary.

By the end of 1929, improved engines had been built and tests on them had been conducted in several laboratories. The new engine adopted more or less as a standard had a single cylinder with a variable compression head. The spark timing was controlled in such a manner that the spark was automatically adjusted when the compression ratio was changed. From time to time the operating conditions have been changed in order to bring the laboratory and actual road determinations as closely together as possible. The operating conditions of the engine according to various test methods are as follows:

	C.F.R.* Research Method	C.F.R.* Motor Method	L.3. Ethyl Corp. Method
Engine speed, r.p.m.	600	900	900
Jacket temperature, °F.	212	212	212
Air-fuel ratio	for maximum knock	same	same
Spark advance (B.T.D.C. at 5:1 ratio)	.....	26 degrees	16 degrees
Mixture temperature	atmospheric	300 °F.	260 °F.

*Cooperative Fuel Research Committee.

Unfortunately, the octane-number scale is not yet a true standard whereby the actual anti-knock value of a fuel

can be determined. Under the guidance of the Coöperative Fuel Research Committee, five extensive test programs have been conducted for the purpose of correlating laboratory octane numbers with road performance. These tests have shown, in many cases, that wide divergence may be expected not only between cars of different makes but between different cars of the same make and model. It is doubtful whether a laboratory knock-testing method ever will be developed that will perfectly correlate the laboratory octane number with the actual engine performance. Further test programs are in progress, and no doubt other changes will be made from time to time in operating conditions and methods.

Reference Fuels

The earliest use of comparison methods in knock-rating measurement disclosed the need for some kind of calibrated reference standard. Usually a laboratory would set aside a supply of some stable stock, either of very low or very high anti-knock quality. The rating of a sample was determined by the amount of some anti-knock compound required in the standard or in the sample to obtain a match.

Numerous methods of measuring the anti-knock rating were used. Some technicians reported their results in terms of the amount of aniline, tetraethyl lead, benzol, toluol, or xylidine required in a reference fuel to match the fuel being rated. Some technicians added sufficient benzol to a straight-run gasoline of poor anti-knock quality to match the sample being rated. The result was reported in "benzol equivalent." The source and nature of the benzol-equivalent rating reported by different laboratories varied widely.

In 1930 the Coöperative Fuel Research Committee recognized the confusion that existed because of the use of so many different knock-rating scales and adopted the present primary standards, n-heptane and iso-octane. Normal heptane is refined from pine oil, and iso-octane is produced synthetically from tertiary butyl alcohol. These pure hydrocarbons do not deteriorate in storage and can be easily reproduced. N-heptane has a low anti-knock value, and iso-octane has a very high anti-knock value; so an octane-number determination is made by finding a blend of these two fuels that has the same knock as the gasoline being tested. The physical properties of the primary standards are very similar:

	Iso-octane	N-heptane
Boiling point, °F	211	209
Specific gravity	0.6953	0.6889
Gravity, degrees A.P.I.	72.0	73.9
Air-fuel ratio for complete combustion	15.2	15.2

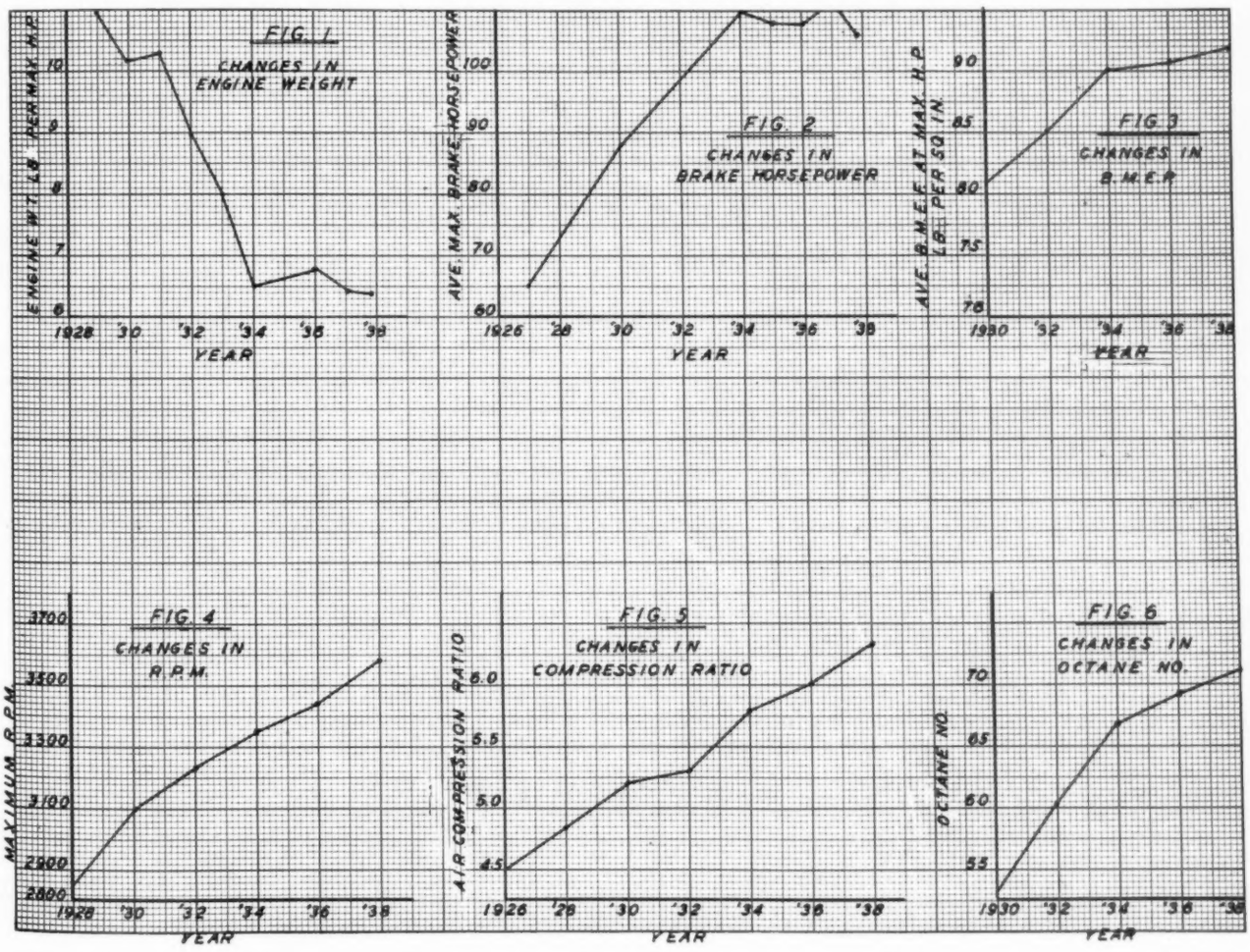
It may be noted that variations in the proportions of these two standards in blends will not affect the air-fuel ratio.

The cost of the primary reference fuels is high—about $20.00 per gal., consequently several companies have set aside quantities of special non-volatile gasolines that have been carefully standardized by iso-octane and heptane. Blends of these secondary reference fuels are used in making the actual knock-rating determinations. The nature of two of these secondary reference fuels is shown:

	Low octane fuel	High octane fuel
Octane number	44.2	76.0
Gravity, degrees A.P.I.	62.8	67.3
Vapor pressure, lb. per sq. in.	3.9	6.4
Boiling range, °F	133-361	122-316

Trends in Engine Design

The automobile engine has undergone considerable change in the last decade. Fig. 5 shows that the compression ratio has increased from 4.8 to



6.3. The engine weight has decreased from 11 lb. per hp. in 1929 to 6.4 lb. per hp. in 1938, as shown in Fig. 1. The average maximum b. hp., shown in Fig. 2, has increased from 65 to over 110. Engine speeds, as depicted in Fig. 4, have increased from an average maximum of about 2750 r.p.m. in 1927 to nearly 3600 r.p.m. in 1938. The b.m.e.p. indicates more correctly the higher average cylinder pressures than does the compression ratio, as it includes the effect of such factors as valve timing, volumetric efficiency, spark advance, and other features of engine design. The b.m.e.p. has increased from 74 lb. per sq. in. in 1927 to 92 lb. per sq. in. in 1938 (see Fig. 3).

These figures show that the efficiency of the automobile engine has increased considerably during the last ten years. This increase in efficiency would not have been possible without an anti-knock fuel. Fig. 6 shows the change in octane number of the regular grade of motor fuel for this same period from which it is evident that the improvement in anti-knock quality of the fuel has paralleled the increase in efficiency of the modern engine.

Factors in Detonation

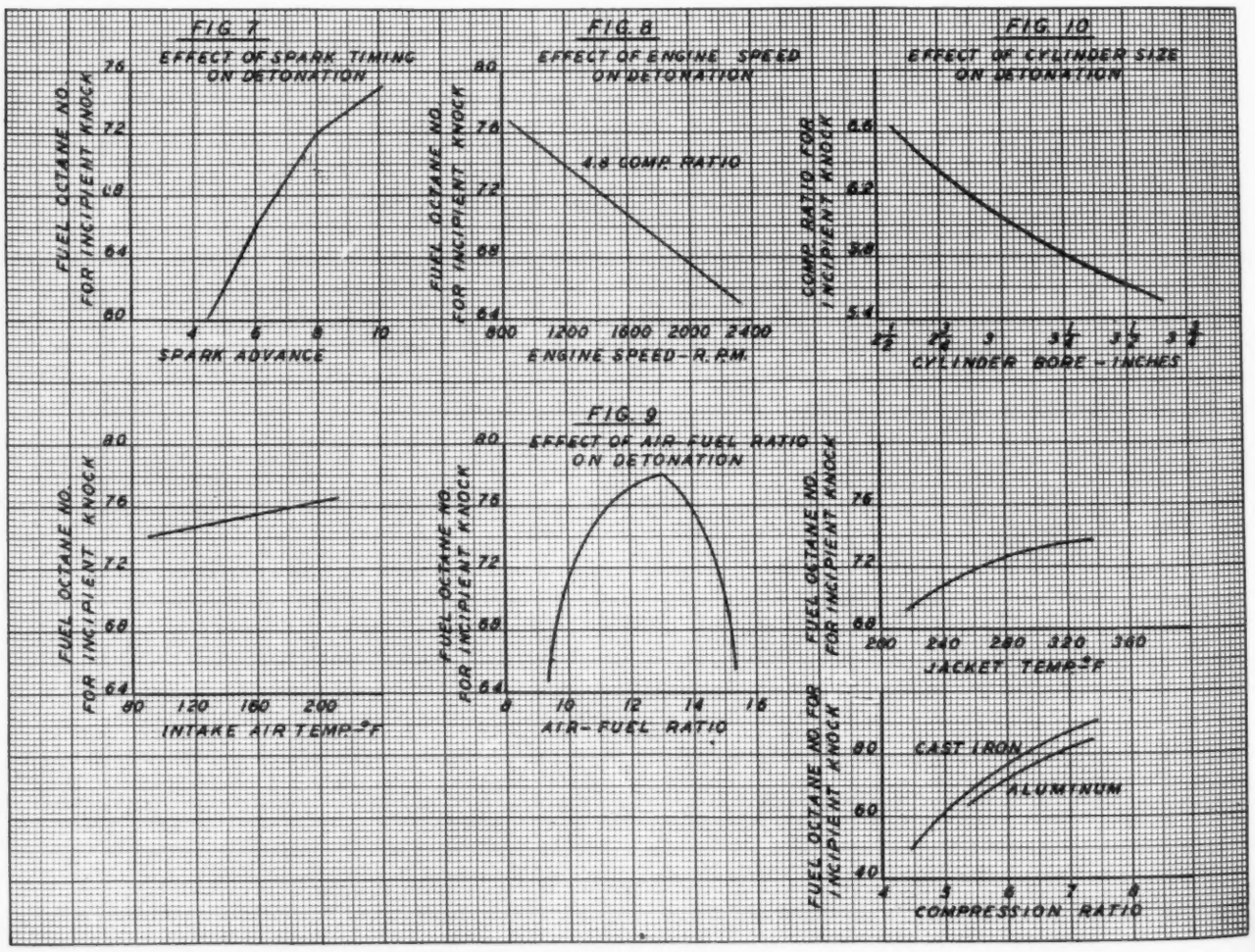
Detonation in an automobile engine is influenced by so many factors that it becomes a very complicated phenomenon. There are fuel factors, such as the inherent anti-knock quality of the gasoline; engine factors, such as compression ratio, spark advance, air-fuel ratio, carbon accumulation, size of the cylinders, distribution of fuel in the cylinders, and materials of construction; operating factors, such as speed, road grade, atmospheric temperature, and humidity. Some of these factors have considerable importance; others do not affect the degree of knocking to any great extent.

Fig. 7 shows the effect of spark advance, one of the greatest factors in detonation. The octane number requirements for this particular engine vary from 60 to 75 during a change in spark timing of only six degrees. A recent survey has shown that more than half of the automobile engines in use today have the ignition adjusted so that the spark is less advanced than the factory setting. The great effect that the spark timing has on knocking no doubt accounts for some of the apparently inconsistent instances where one car will knock and another car of the same model and make will not knock, both cars using the same fuel. An advance of one or two degrees in the spark timing is sufficient to make an engine knock perceptibly using a fuel having an octane number that causes only incipient knocking at the recommended spark setting.

Fig. 8 shows the effect of engine speed on detonation. This curve bears out the common experience of the motorist. Usually knocking is noticed when the engine is under a heavy load or when the throttle is suddenly opened. When the engine and the car have attained a high speed, the momentum tends to take part of the load off the engine, and the knock decreases.

Fig. 9 shows the effect of air-fuel ratio on detonation. Lean mixtures and rich mixtures do not knock so badly as does a perfect mixture. A perfect mixture has the proper proportion of air to give complete combustion of the fuel but, at the same time, a large excess of air is not present to occupy needed space. The perfect mixture knocks worse because the engine is generating more power and the combustion temperatures are higher.

EDITOR'S NOTE: The final part of this article will appear in an early issue.



HIGH TEMPERATURES?

THIS NEW BYRON JACKSON PROCESS PUMP IS BUILT TO TAKE 'EM

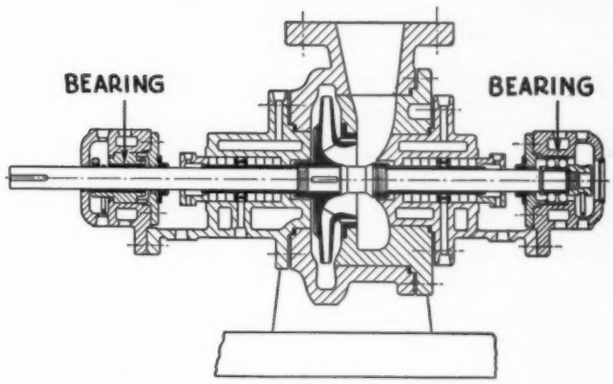
The TYPE DB PROCESS PUMP

...is especially suited to those service conditions where the high temperature of the pumped liquid may introduce piping strains too heavy for an overhung case construction to withstand. The pump case is supported at its center line to assure maximum freedom from distortion under heavy strain, and to permit expansion without causing misalignment. Bearings are used on both sides of the pump case, thus giving the shaft positive support at both ends.

The design permits removal of the entire rotating element without disturbing either the piping or the driver. Because of the extension of the shaft to the outboard bearing, the shaft of this pump can readily be extended for dual drive.

ENGINEERING FACTS

DESCRIPTION: Both the TYPE DB and the TYPE BM Process Pumps are horizontal, single suction, single stage pumps designed for heavy duty service. The vertically split case with circular gasket seal permits tight joints at high temperatures and pressures. Nozzles are cast integral with the case, which permits dismantling without disturbing piping. APPLICATION: Any liquids, whether hot or cold, where service is mechanically or hydraulically severe. Enclosed impeller types furnished for clean fluids at temperatures up to 850 degrees F. Open impellers with renewable wearing plates furnished for liquids carrying abrasives. Suited for practically any process work, whether high pressure or high vacuum. STANDARD MATERIALS: Cases and impellers may be cast iron, Meehanite, Ni-resist, carbon or chrome alloy steel, or almost any alloy best suited to particular service requirements. Trim may be bronze, chrome, steel nitrided Nitraloy, Stellite or other similar materials required for any particular service.



Type DB Pumps are available for capacities from 10 to 900 g.p.m., at heads up to 500 feet.

The TYPE BM PROCESS PUMP

...has one stuffing box only—a simplicity of design attainable only with overhung impeller construction. As this stuffing box operates at greater than suction pressure, the unit is well adapted to vacuum service. Where the material being pumped is difficult to hold in a stuffing box, this unit with its single stuffing box, possesses a decided advantage. These pumps are available for capacities from 10 to 7,000 g.p.m. at heads from 20 to 500 feet.

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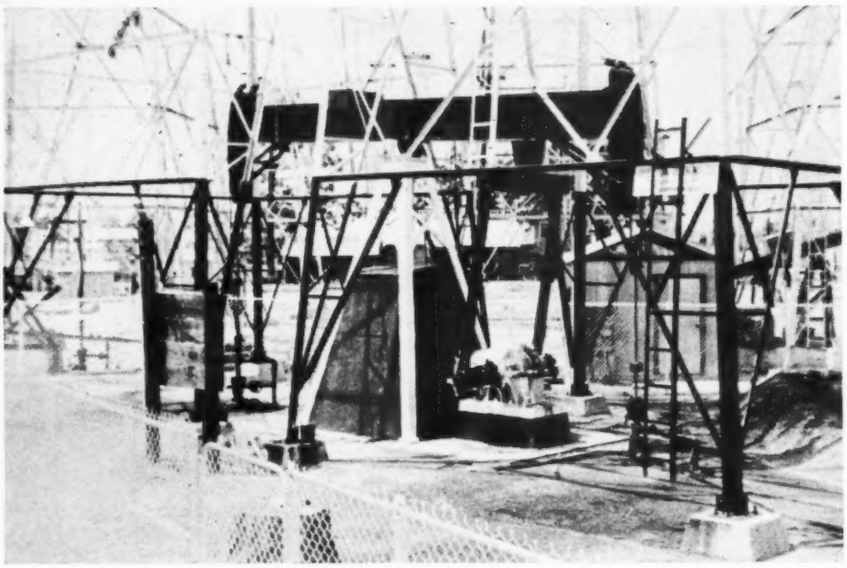


Fig. 1. This unit pumps two wells using a single beam

Weights of both wells virtually identical so that minimum of power is required

Two Wells Pumped by a Single Beam in East Texas Installation

RAPIDLY becoming known as the proving ground for pumping devices in which virtually every type of pumping unit is being employed, the East Texas field can offer a no more interesting pumping arrangement than the one shown in the accompanying photographs.

Two wells are being pumped using a single beam at both ends of which the rod-lines of the wells are suspended. The geared unit driven by an electric motor is connected to the beam by a double pitman attached midway between the fulcrum and one end of the beam. No counterweights are required on the crank of the unit. The close-up view of the framework supporting the fulcrum shows the small counterbalance placed on the beam as the only extra weight required to balance the pumping action.

This direct and simple method of coupling two wells together so that each balances the other represents, in this instance, what is probably one of the most efficient pumping units that could have been devised. Both wells are virtually twins, having approximately the same depths and the same sized tubing, rods, and pumping barrels, so that the respective weights of the two wells are almost identical. The power required, then, is very near the minimum required to offset the friction, both mechanical and fluid, and to lift the volume of oil in the tubing during each upstroke of the rod-line.

This pumping unit is situated in the townsite of Kilgore and, so far as is known, it is the only one of its kind in operation. Only one area of congested well-spacing, the dense drilling in the Kilgore townsite, is demonstrated in Fig. 1 in which two other wells may be seen in the background, all four wells being on a plot of ground less than 100 ft. square.

Wells so closely spaced are the rule rather than the exception in the East Texas field. As more and more wells are placed on the pump, there will undoubtedly be many instances where two wells could be pumped from a single beam, as in the wells described. The method is of enough interest to warrant its consideration by production engineers in planning the manner in which closely-spaced wells are to be pumped.

Fig. 2. Only a small counterweight is required on the beam

LAUGH WITH BARNEY

Tourist (down South): I see you raise hogs almost exclusively down here. Do they pay better than corn and potatoes?

Native: Wall, they don't suh, but hogs don't need no hoein'.

* * *

A beggar held out two hats to a passerby. "Mister," he said, "will ye gimme a nickel for a cup of coffee?"

"Sure," replied the passerby, "but what's the idea of two hats?"

"Well," said the beggar, "business was so good that I had to open a branch."

* * *

Loony Daffynitions

Nudist: A person who goes coatless and vestless and wears trousers to match.

Honeymoon: The last vacation a married man has.

After Dinner Speaker: One who talks on a full stomach and an empty head.

Love: It begins when a woman sinks into a man's arms, and ends up with a woman's arms in a man's sink.

Bachelor: A man who never makes the same mistake once.

Scram: An American word meaning, "Get the Hell outta here."

Efficiency Expert: A cow that gets hiccoughs and churns her own butter.

Politician: A man who stands for what he thinks other people will fall for.

Diplomat: A man who remembers a woman's birthdays, but not her age.

Political Science: The science of interfering in public affairs.

Man: The only animal that can be skinned more than once.

Socialist: A man who has nothing and wants to divide it with you.

—*Bridgeport Bulletin.*

* * *

Mother: Daddy and I won't be home tonight, Johnny. Do you want to sleep alone or with nursie?

Johnny (after some deliberation): What would you do, Daddy?

* * *

Mrs. MacTavish: My little boy has just swallowed a ten-dollar gold piece.

Neighbor: Gracious, is the child in danger?

Mrs. MacTavish: No, thank goodness, his father's out of town.

Pop: Well, I received a note from your teacher today.

Son: Honest, Pop? Give me a quarter and I won't breathe a word about it.

* * *

She: Will you love me as much in August as you did in February?

He: Oh, more—dearest. There are more days in August.

* * *

"What would your wife do if you should die tomorrow?" asked the insurance salesman as he popped in the door.

But we had the answer to that one before he could continue.

"She'd probably go to the funeral, if it wasn't the day for her bridge club," we parried.

* * *

Girls have changed. They still don't trust a man too far, but in the old days they would not trust him too near.

* * *

Sign in Scotch Shop

We require a deposit of 50 percent from customers we don't know and 100 percent from some we do know.

* * *

A banker, in the height of the depression, got a temporary job as a filling station attendant. His first customer drove in, and asked for ten gallons of gas.

"How far are you traveling?" asked the ex-banker.

The customer explained his trip in detail. Said the banker: "Don't you think you could get along with five all right?"

* * *

Girl Customer: Does this lipstick come off easily?

Cosmetics Clerk: Not if you put up a fight.

* * *

"Young man, I understand that you have made advances to my daughter."

"Yes, sir, I wasn't going to say anything about it, but now that you have, I wish you could get her to pay me back."—*Lufkin Line.*

* * *

"Say, Jane, isn't it time the baby said Daddy?"

"No, John; I've decided not to tell him who you are until he gets stronger."

Mrs. Smythe-Brown was making the final arrangements for her elaborate reception.

"Bridget," she said to her old servant, "for the first thirty minutes after six o'clock I want you to stand at the drawing-room door and call the guests' names as they arrive."

Bridget's face lit up.

"Very well, ma'am," she replied, "I have been wantin' to do that to some of your friends for years."

* * *

An actor's suggested epitaph for a much-married Hollywood matron: "At last she sleeps alone."

* * *

The Sagacious Canine

A family purchased a new dog, recommended to be a super-intelligent animal and well trained in the matter of house conduct.

The first time they left it alone in the house they found the dog on the davenport when they returned. The animal was punished.

The next evening the dog was left alone again in the home. When the family returned, he was sitting in front of the davenport—but the davenport was warm to the hand. So the animal was again punished.

The next evening, left alone again, upon the return of the family, they found the dog sitting in front of the davenport, blowing on it.

* * *

Rastus was in trouble again, and the Judge asked him if he were guilty or not guilty. "Guilty, suh, I think, but I'd rather be tried to make sure of it."

* * *

A friend was telling us of the two little worms—one was crawling East the other West, then they met—one stopped, the other crawled right on.

* * *

Cop: Lady, there's no red light on your car.

Blonde: No sir, it's not that kind of car.

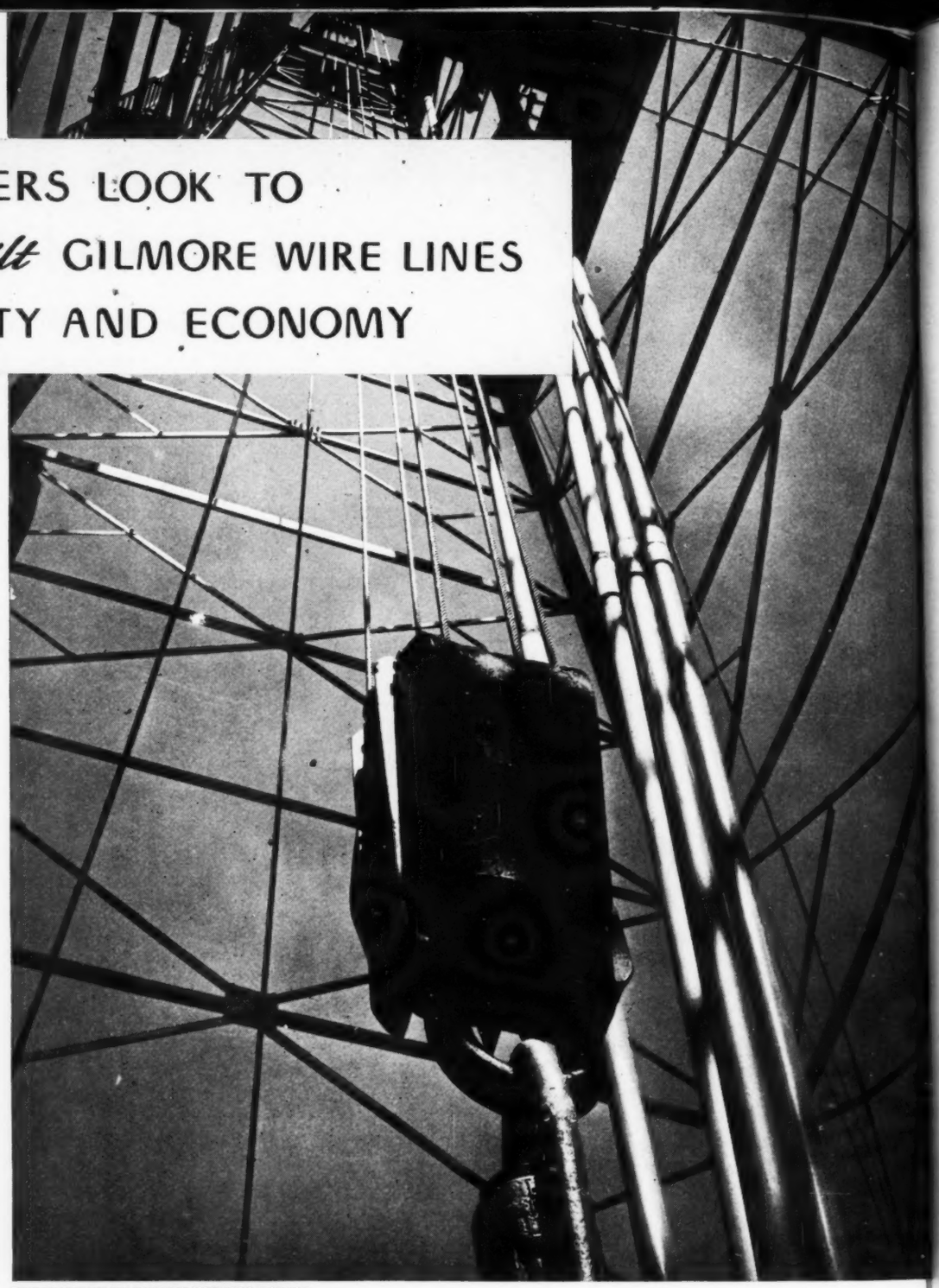
* * *

There were two old maids who went for a tramp in the woods and came back feeling a little bum inside.

* * *

"If you refuse me," he swore, "I shall die." She refused him. Sixty years later he died. Love is so sad.

DRILLERS LOOK TO J&L *Precisionbilt* GILMORE WIRE LINES FOR SAFETY AND ECONOMY

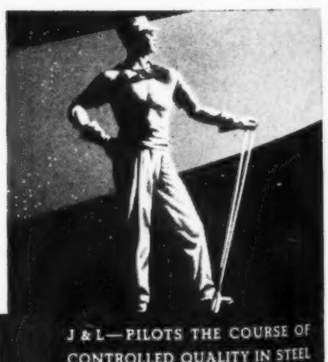


PHOTOGRAPH BY ROBERT YARNELL RICHIE

›r maximum efficiency in your ›eration and safety and de- ndability on any drilling job use J & L Precisionbilt Wire nes. They have the strength, xibility and abrasion-resis- nce to stand up under hard, ntinuous service.

J & L Precisionbilt Lines are ade exclusively of J&L Con- olled Quality (CQ) Steel on west wire rope making ma- ines which work to tolerances 1/1000 of an inch. Lubrication of these lines is scientifically applied for lasting otection—long service.

J&L Precisionbilt Lines are helping increase the efficiency, economy and safety of field operations for hundreds of crews. When you need wire lines — specify J&L ecisionbilt. Write today for your copy of our catalog, Oil Country Lines.



J & L—PILOTS THE COURSE OF CONTROLLED QUALITY IN STEEL

IONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS

GILMORE WIRE ROPE DIVISION

PITTSBURGH, PENNSYLVANIA

J&L STEEL

J & L—PARTNER IN PROGRESS TO AMERICAN INDUSTRY

Running Tour
WITH MEN IN THE INDUSTRY

A. A. (ANDY) FOMILYANT, who formerly was in charge of field editorial work for a petroleum publication, recently became associated with Merco Nordstrom Valve Company and Pittsburgh Equitable Meter Company

A. A. FOMILYANT

in sales engineering work. Fomilyant received his engineering education at California Institute of Technology. He is in the above company's Los Angeles offices.

J. H. HOWARD, chief engineer for McEvoy Company, attended the British-American Engineering Congress of the American Society of Mechanical Engineers in New York, September 4-8. Afterward he toured New York and eastern Canada and returned to Houston, Texas, September 18.

FRANK M. HOLLOWAY, formerly manager at Houston, Texas, is now in charge of the eastern sales office at 30 Church Street, New York City, for the Vapor Recovery Systems Company, Compton, California. He is being assisted by **JAMES G. BURNETT. JOE M. GREENLEE** is in charge of the Houston office.

E. C. DILGARDE of Casper, Wyoming, who has been identified with the marketing of oil-well supplies in the Rocky Mountain area for many years, has recently been appointed independent sales and service representative for Security Engineering Company, Inc., of Whittier, California. Dilgarde will direct the sales and service in the states of Colorado, Idaho, Montana, Utah, Wyoming, and the northern half of New Mexico for Sievers reamers and reamer parts, Securaloy drillable products, and other items manufactured and marketed by Security Engineering Company. A suitable warehouse stock of Security products will be carried at 130 West Railroad Avenue, Casper, Wyoming, but the fields will be served jointly from this warehouse and by established distributors and dealers throughout the territory, it is announced.

W. A. PATTERSON, president of United Air Lines, has announced that three prominent oil men have qualified for membership in United Air Lines 100,000-Mile Club. They are **S. B. MOSHER,** president of Signal Oil and Gas Company, Los Angeles, California, **E. M. BURNHAM,** Pacific Coast sales manager for the Standard Oil Company, San Francisco, California, and **H. F. VOGEL,** of the Signal Oil and Gas Company, Detroit, Michigan. The 100,000-Mile Club is an organization confined to persons who have traveled 100,000 miles or more by commercial airliner.

A. W. TYRRELL, tool pusher for Sarawak Oilfields, Ltd., has returned to Borneo, N.E.I., after a combined visit and business trip to the United States.

L. H. J. HERSCH, engineer and superintendent for the Caribbean Petroleum Company, has been in the States on leave, spending most of his time in the Mid-Continent area.

F. H. BAILLY, representative for Pantepec Oil Company of Venezuela, has spent some time in California with his wife and family. He recently returned to Caracas, which is the headquarters for his company.

W. HOGENHUIS, engineer for B.P.M. at Tarakan, Borneo, has been in California on business. He will return to the Netherland East Indies in the near future.

MORRIS PITTMAN, who has been in the employ of the Humble Oil and Refining Company in Texas as a driller, has been sent to Caripito, Venezuela, as a drilling engineer for the Standard Oil Company of Venezuela.

E. C. EDWARDS, who has been stationed at Bakersfield, California, for the General Petroleum Corporation, and **A. F. BARRATT,** who has been at Casper, Wyoming, for the same company, have been transferred to the Alberta, Canada, area for the purpose of making a geological study.

L. B. RIGGINS, JR., until September 1 employed as petroleum engineer by Baker Oil Tools, Inc., has just gone with Pantepec Oil Company of Venezuela. He recently left for New York and from there will go to Caracas, Venezuela, where he will report for duty.

W. S. HENDERSON has been made managing director of the Anaconda Oil Company, Alberta, Canada. He has been acting managing director since May.

MILTON M. COOKE, petroleum engineer for the Mene Grande Oil Company at Lake Maracaibo, Venezuela, has returned to the United States and expects to remain here permanently.

PIET SCHOUTE, exploitation engineer with B.P.M., will shortly leave California for assignment in one of the Shell foreign operations.

PARKER L. MELVIN, independent producer in the Bradford district and vice-president of the Pennsylvania Grade Crude Oil Association, has been appointed oil observer for the State of Pennsylvania by Governor James.

HENDRIK BLUEMGARTEN, from The Hague, Holland, office of the Royal Dutch-Shell Group, is now in Colombia, South America.

L. E. BOTKIN, superintendent for the Illinois Oil Company, who has been stationed at Kermit, Texas, is now at Coahoma, Texas.

JACK WOODWARD, petroleum engineer at Kermit, Texas, for the Magnolia Petroleum Company, and **ED DOWNING,** district engineer at Mirando City, Texas, have exchanged positions.

W. A. ALEXANDER, general superintendent in South Louisiana for the Shell Oil Company, has been made chief exploitation engineer for the company and transferred to Houston, Texas. His place is being taken over by **S. F. BOWLBY,** who has been chief exploitation engineer. The latter's headquarters will be at Iowa, Louisiana.

DR. F. J. SANDERS, head of the technical service division of Standard Oil Company of Ohio since 1934, has been named superintendent of the company's Toledo refinery, succeeding **J. BLAKE MIDDLETON, GEORGE W. HANNEKEN,** vice-president of the company, has announced. Middleton, who went to Toledo from Cleveland in 1936, has been named foreign representative of Socony-Vacuum Oil Company and will be in charge of its refinery operations in Europe, having headquarters at The Hague.

Dr. Sanders is a graduate of Texas Technological Institute and received his doctor's degree in chemical engineering at Yale University. Joining the Standard of Ohio in November, 1934, he and J. L. Collins organized the technical service division that now embraces a staff of 18 men whose full time is devoted to improvement of processes and equipment. Dr. Sanders has already taken up his new duties in Toledo.

J. A. SMITS, petroleum engineer, the Royal Dutch-Shell Group, The Hague, Holland, is making a tour of inspection of properties of the Shell Oil Company in the United States.

L. C. ROBERTS, JR., has resigned as division geologist for the Stanolind Oil and Gas Company, Houston, Texas, to enter business as a consulting geologist. He has been succeeded by **R. B. MITCHELL.**

C. J. McCLURG has been named superintendent of motor transportation by the Sinclair Prairie Oil Company, succeeding the late **SAMUEL C. PHILIPS.** He has been first assistant of the department.

W. E. CHILDERS, machine shop foreman with the Mene Grande Oil Company, will soon return to Venezuela, after spending his leave in the United States.

E. M. (MIKE) CLORAN, formerly in the engineering department of the Pittsburgh Equitable Meter Company and Merco Nordstrom Valve Company in Pittsburgh, Pennsylvania, was recently transferred to the company's Los Angeles, California, office. He will assume sales engineering duties,

E. M. CLORAN

chiefly contacting gas and petroleum departments of Southern California operators. After graduating from Harvard in 1931 he became associated with Stone and Webster and later was with Atlas Ferric Nitrogen Corporation. He is a member of the sub-committee on Industrial Instruments and Regulators of A.S.M.E.

R. W. GRADY is president of a pipe-line construction firm organized recently in Shreveport, Louisiana, known as Swink and Grady. **D. A. SWINK** is vice-president and **H. GRADY** secretary-treasurer.

EARL CARNAHAN, production superintendent in the Santa Fe Springs field, California, for the General Petroleum Corporation, has completed 25 years' service with the company. He began as a well puller.

C. I. WRIGHT, an assistant engineer at the Shell Oil Company's Martinez, California, refinery, has been promoted and transferred to the Shell Chemical Company.

D. M. WALSH, refinery superintendent for Trinidad Central Oilfields, Ltd., Tabaquite, Trinidad, British West Indies, has resigned to become affiliated with Masons, Ltd., Port-of-Spain, Trinidad.

ANDREW H. IRELAN and **FREDERICK W. NASH, JR.,** joined the staff of the Alliance Oil Corporation, New York City, effective September 1, it was announced by **L. C. QUACKENBUSH,** president. Irelan joins the company as vice-president, resigning from the position as manager of the Lubricant Department, Cities Service Oil Company of Pennsylvania. Nash has been appointed treasurer. Graduating from Princeton in 1932, he joined the staff of the accounting firm of Peat, Marwick, Mitchell and Company. He resigned from this concern to go with Alliance Oil. Both Irelan and Nash will be connected with the New York office, 9 Rockefeller Plaza.

CHARLES E. HOBLEY, geologist for the Asiatic Petroleum Company, has returned to Curacao after spending some time in the United States.

G. E. NEWLIN, a member of the board of directors of the Union Oil Company of California, has been made a vice-president of the company.

D. T. McIVER has been appointed assistant to the president of the Freeport Sulphur Company, it was announced in New York September 5 by **LANGBOURNE M. WILLIAMS, JR.,** president of the company. McIver, a native of Texas, has been assistant general manager with executive duties since 1933, being stationed in New Orleans, Louisiana. He became associated with the company 16 years ago in the production department at Freeport, Texas. In 1930, he was placed in charge of lands and leasing development. In his new capacity, he will continue to serve also as assistant general manager, dividing his time between the company's properties in Louisiana and Texas and its offices in New York.

D. LEE ADAMS, driller with the Trinidad Petroleum Development Company, having headquarters at Siparia, has been on vacation in California. He is accompanied by Mrs. Adams.

RALPH H. KING, Dallas, Texas, formerly associate editor of *The Petroleum Engineer,* has accepted a position as petroleum engineer with the Kansas Geological Survey, Lawrence, Kansas, assuming his new duties on September 1. He will work under the direction of **DR. E. A. STEPHENSON,** head of the petroleum engineering department of the University of Kansas, and **DR. R. C. MOORE,** director of the survey and head of the geological department of the University of Kansas. Under the supervision of Dr. Stephenson his work will be concerned with the economic geology of oil and gas fields, and under Dr. Moore his efforts will be in the field of paleontology.

H. W. KEENAN, engineer with The Texas Company, has been transferred from Tomball to El Campo, Texas.

PAUL COFFIN, assistant superintendent of gasoline plants for the Lone Star Gas Company, Dallas, Texas, has resigned to become general superintendent of the Shamrock Oil and Gas Company, having headquarters in Amarillo, Texas. **HARRY WHEELDON,** superintendent of the West Texas district of the Lone Star Gasoline Company, has been appointed to succeed Coffin. **J. M. KINDLE,** superintendent of the Lone Star gasoline plant at Trinidad, Texas, has been named to succeed Wheeldon. **W. A. ROBINSON,** chief chemist for West Texas district gasoline plants, becomes superintendent of the Trinidad gasoline plant. **JOHN LEE THOMPSON,** chemist at the Brooks plant, Breckenridge, Texas, has been named chief chemist for gasoline plants in the West Texas district.

JOHN GALLEY, Tulsa, Oklahoma, has succeeded **LESLIE M. CLARK** as district geologist at Wichita, Kansas, for the Shell Oil Company. The latter has been transferred to Centralia, Illinois.

L. L. HAINES has been sent from Oilton, Oklahoma, to Clay City, Illinois, to become superintendent of production for the Pure Oil Company. He succeeds **H. L. PATTERSON,** who is being moved to Corpus Christi, Texas.

LESTER H. HILYARD, driller for California Arabian Standard Oil Company, is now on leave in California. At the end of his vacation he will return to Saudi Arabia.

J. R. JARVIS, superintendent of gasoline plants for the Lone Star Gas Company, Dallas, Texas, is back at his desk after being laid up by illness since July 4.

WILLIAM SCHMITTOU, field superintendent for the Burmah Oil Company, will shortly leave Berkeley, California, where he has been spending a few weeks, to return to Burma.

H. B. WILLIAMS, driller for California Arabian Standard Oil Company, has been in the United States on vacation, and while here was married.

A. W. ROTHROCK, drilling superintendent for Colombian Petroleum, spent his leave in San Diego, California. He has recently returned to Cucuta, Colombia.

C. M. McCALL, storekeeper with the N.K.P.M., has, with Mrs. McCall, been spending his vacation in California. Mr. and Mrs. McCall will shortly return to Sumatra.

E. E. DETTER, tool pusher for U.B.O.T., and Mrs. Detter, recently left Ventura, California, to return to Trinidad.

L. E. SOUTHARD has been appointed foreman of the Richland, Texas, pipe line district of the Lone Star Gas Company, to succeed **JOHN I. PEARCE.** His headquarters will be Groesbeck, Texas. Southard has been assistant foreman of the Joshua district, being stationed at Waxahachie. **OCIE T. GIBSON** succeeds to the latter post. As foreman of the Richland district Southard will have charge of the company's main lines supplying gas to Corsicana, Kerens, Richland, Wortham, Teague, Mexia, Dawson, Cooledge, Munger, and intermediate communities.

You Get Better Field Coatings **with Armco Pipe**

To be of any value a field coating must *stay on the pipe.* That's one reason why thrifty oil companies everywhere prefer Armco Spiral Welded Pipe. Each section is "*shot-blasted*" on the outside before mill priming to remove all dirt and mill scale. This helps reduce corrosion hazards and provides a lasting bond for primer and field coats.

Also, when you use Armco Spiral Welded Pipe, cost estimates are more accurate and bid prices are likely to be lower. This is because Armco Pipe comes in *uniform* lengths (up to 50 feet) that eliminate guesswork. Then too, it can be field welded faster and more economically than other types.

You'll find a diameter and wall thickness of Armco Pipe exactly suited to your needs. Just write, phone or wire our nearest office for prices and reliable delivery promises. The American Rolling Mill Co., Pipe Sales Division, Middletown, Ohio; 538 Mayo Building, Tulsa, Okla.; 3500 Maury St., Houston, Texas.

ARMCO

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SPIRAL WELDED PIPE

LINE PIPE AND SURFACE CASING

MACHINERY and EQUIPMENT

Heavy-Duty Welding and Heating Blowpipe

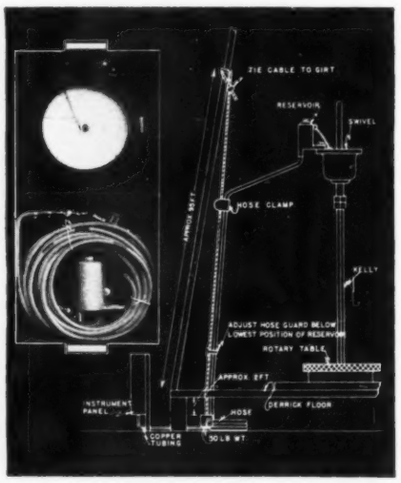
THE usefulness of the oxy-acetylene flame for metal-working operations has been greatly increased by the availability of a large-capacity heating blowpipe. This blowpipe, distributed by The Linde Air Products Company, New York City, and known as the Oxweld Type W-26 Heavy-Duty Welding Blowpipe, is for welding and heating ranges above those possible with ordinary blowpipes, according to the manufacturers. It delivers a tremendous amount of heat to a localized area, and does this so quickly that metalworking and heat-treating can be accomplished at top speed, it is stated.

Extensions for the welding head are available for extra-heavy work, eliminating the necessity for heat shields. The operator works in comfort, removed from the source of heat, and finds the blowpipe, even with the extension, easy to handle because of its excellent balance.

Its applications cover a wide range, including use in the fabrication of tanks and pressure vessels, for making locomotive boilers, for straightening and bending ship plate, for wrinkle-bending large-diameter pipe, and for similar heavy work. It can also be used for lighter work as well as for certain flame-hardening operations.

Automatic Rate of Penetration Recorder

AN Automatic Rate of Penetration Recorder for use on drilling wells has been announced by Martin-Decker Corporation, Long Beach, California. The rate of penetration recorder solves the problem of logging formations as they are drilled. It eliminates the inaccuracies of manual computing methods and provides geologists, engineers, drillers, and drilling departments with a simple, positive way to procure time-drilling information automatically and continuously, the manufacturer states.



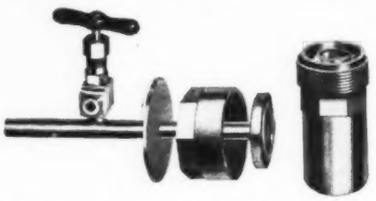
Entirely automatic in operation, the instrument has three simple parts: a water reservoir attached to the swivel, a small-diameter rubber hose connecting the reservoir to the recorder, and a special low-range pressure recorder using charts graduated in "feet of penetration." The system is filled with clear water or an anti-freeze solution for cold weather. In operation, the recorder charts the rate of change in hydrostatic pressure from the reservoir as the kelly lowers while drilling. It instantly records formation breaks as they occur and charts a clear, continuous record of bit penetration rate.

Information given by the Martin-Decker Rate of Penetration Recorder concerning formation changes is valuable in deciding the coring program. The instrument also indicates porosity of the formations, as well as the formation breaks. This information is a useful supplement to the electrical log, especially in limestone formations, it is stated. The graph obtained is also valuable as a guide for future production work such as perforating, running tubing, setting packers, etc. When information procured by the instrument is used to supplement data on weight, torque, table speed, and mud pressure, a clear picture of bit performance in various formations is obtained.

For full particulars write Martin-Decker Corporation, Long Beach, California.

Tag-A.S.T.M. Bomb

C. J. TAGLIABUE MANUFACTURING COMPANY announces the development of a new Tag-A.S.T.M. bomb for determining gum stability of gasoline. This bomb is used in connection with the latest A.S.T.M. Method for gum stability of gasoline, D525-39T. This method describes the procedure for an accelerated



oxidation test of gasoline, by means of which the induction period is determined. The induction period may be used as an indication of gum stability, i. e., the tendency of gasoline to form gum during the period of storage.

The method involves the use of a pressure gauge, preferably of the recording type. The so-called "break" point of gasoline is defined in the method as that point provided by a pressure drop of exactly 2 lb. in 15 min. and succeeded by a drop of not less than 2 lb. in 15 min.

The number of minutes from the time the bomb is placed in the bath, held at a specified temperature, to the "break" point is recorded as the induction period.

Copies of Bulletin 1206 illustrating and listing this new bomb will be sent upon request to C. J. Tagliabue Manufacturing Company, Brooklyn, New York.

(P/A = S)

. . . OR DOES IT?

THIS SIMPLE FORMULA, load divided by area equals stress, serves well enough in the laboratory to establish the stress in a test specimen, but it fails utterly when applied to sucker rod strings under field conditions. In fact, no one yet knows much about the various load conditions to which sucker rods and couplings are subjected, hence there is no formula for calculating the endurance limit of a string of sucker rods in the well.

One thing is certain — the vast majority of sucker rod breaks is actually due to fatigue failure. Fatigue failure is brought about by stress, and is accelerated by "stress raisers". These are generally in the form of structural variations, scale, corrosion pits, notches, dents, other minute surface defects, and improper forging design and practice. The fluid being pumped often increases the harmful effect of the "stress raisers".

Axelson pioneered, and has made an established practice of, most of the manufacturing methods and inspection routine which eliminate detectable "stress raisers" in your sucker rods and couplings. No claim of perfection is made, but each of the types of Axelson Sucker Rods is the highest quality that modern knowledge and manufacturing skill can enable us to produce from the steels available today.

Let us send you the 58-page book "Not How Much — But HOW WELL" which describes and illustrates every phase in the manufacture of Axelson Sucker Rods and Couplings. Or, if you already have a copy, may we suggest you read it again?

AXELSON MANUFACTURING COMPANY

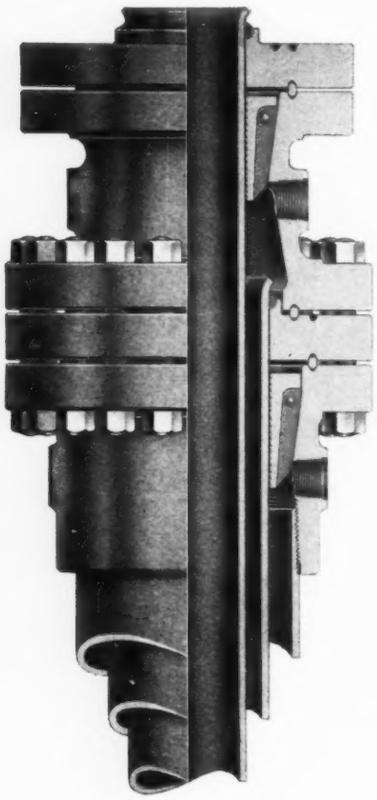
6160 South Boyle Avenue, Los Angeles, California

Saint Louis, Mo. • New York City • Tulsa, Oklahoma

AXELSON
SUCKER RODS

Cameron Type "J" Casinghead

CAMERON IRON WORKS, Inc., Houston, Texas, has announced a new slip-suspension type casinghead, known as the Type "J", which, according to the manufacturers, provides a high degree of flexibility, safety,



and speed of installation. This new head, herewith shown in cross-section, accomplishes the seal of the annular space by means of a welding flange that provides for a construction weld between the pipe and raised neck of the flange. A.P.I. steel ring gaskets complete the all-steel seal between flanges and casing strings. The construction weld prevents pipe from sagging in the slips and swaging, and also holds the pipe string rigid.

After casing is suspended, it is cut off above the slips, the Type "J" welding flange is slipped over and bolted to the casinghead or spool, and the construction weld applied. A Type "M" welding flange can be supplied, if desired, at a slight additional cost, which provides a means of testing the efficiency of each construction weld by hydraulic pressure before installing casing spool or Christmas tree.

Slip suspension permits landing casing at any desired point in the well and suspending with exactly the desired amount of tension in the string. The slips are assembled around the casing by means of aligning bolts, which insure equal distribution of weight when the casing is landed. The Type "J" casinghead is of the flanged type, eliminating all casing size threaded connections above the surface pipe threads.

Cameron Iron Works, Inc., will supply interested operators on request, with complete information on the Type "J" casinghead.

J. & L. Cement-Lined Steel Pipe

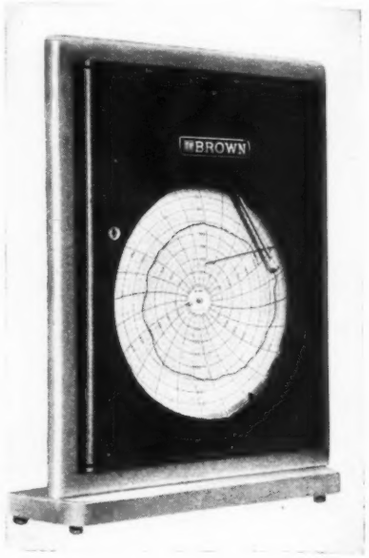
AN improved process for the manufacture of cement-lined steel pipe for the transmission of highly-corrosive fluids has been announced by the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. The product is made on a new high-speed mill especially designed for the purpose. One of the features of the new plant is a pilot ball mill in which trial batches of the pipe lining mix are ground to determine the correct formula for each specific application before production batches are ground in the main ball mill.

In the J & L process, a special formula is used in lining the pipe. A measured quantity of the special mix is placed in the pipe and forced against the walls by a process that, at the same time, extracts a high percentage of the water. This, it is pointed out, is desirable in attaining a lining having the highest physical properties. The process results in extremely even distribution of the mixture, it is stated. After curing, the pipe is given a final inspection and made ready for shipment.

The combination of the special mixture and the process produces an even interior coating in the pipe, so smooth that the lining has a lower friction coefficient than the original pipe, yet is strong enough that no special handling in the field is required to protect the lining, except that the pipe cannot be deformed. The pipe can be shipped, cut to length, and fitted the same as unlined pipe, the lining being able to withstand without chipping any blow on the exterior that does not actually dent the pipe. This pipe has the same working pressures as regular steel pipe and, although J. & L. does not manufacture fittings, it is in a position to supply lined fittings for use with this pipe, which is available in sizes of ½ to 12 in., inclusive, and 14 in., O.D., in special cases.

Thermometer and Pressure Gauge

A NEW line of temperature and pressure recorders, indicators, and controllers has been placed on the market by The Brown Instrument Company, Wayne and Roberts Streets, Philadelphia, Pennsylvania. These instruments include thermometers, indi-



cating and recording types for temperatures from minus 40°F. to 1200°F.; and indicating or recording pressure and vacuum gauges for ranges from 6 lb. of water to 2500 lb. per sq. in. and on vacuum ranges of 10 in. of mercury and over. All types are offered in one, two, or three pen models.

The powerful, flat, spiral actuating elements have ample pen torque without sacrificing speed of response; especially heat-treated to insure permanent calibration, they have exceptional overrange capacity, the manufacturer states.

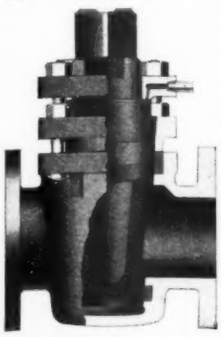
A special safety link between the actuating element and pen provides an overload safeguard protecting the mechanism from damage if the pen is moved in either direction manually.

The chart is firmly secured to driving mechanism by tapered stud and tapered chart positioning stud, eliminating chart knob and chain. Charts, when renewed, are automatically in time, as the tapered position stud is in effect the hour hand of the electric clock. If current failure makes it necessary to reset the chart to correct time line, a friction clutch permits manual rotation for chart setting.

A bulletin, No. 2-17, describing this new line of instruments, has been issued and a copy will be sent on request.

Asbestos Groove-Packed Iron Cocks

A NEW line of asbestos groove-packed iron cocks has been announced by the Reading-Pratt and Cady Division of the American Chain and Cable Company, Inc., Bridgeport, Connecticut. This new type has the usual gland to hold the plug in position and an additional gland to compress the top packing. Pressure on the plug and packing can be controlled separately. This new design results in a 50 percent reduction in the effort required to operate the cock and there is less wear on the moving parts, the manufacturer states.



Alemite lubrication is provided through a groove between the top of the plug and the top gland. R-P&C Dual Gland Cocks are made in sizes from 1½ in. to 6 in. for 125-lb. and 250-lb. steam pressures. For corrosive or high-temperature services they can be supplied made of Ni-Resist (nickel-chrome) iron.

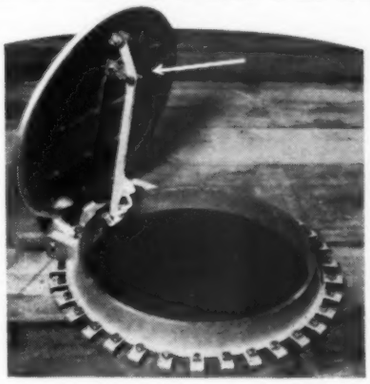
Offer New Service

BELIEVING that there has been a long-felt need for a general well-servicing unit that embodies a lease service-hoist and spudder unit that is completely versatile, the Unit Rig and Equipment Company, Tulsa, Oklahoma, offers a new idea. Heretofore, operators and contractors for this class of service have had no choice other than the conventional double-drum spudder unit in permanent combination, it is asserted. Although the combination service-hoist and auxiliary spudder unit does not entirely supplant the conventional double-drum spudder unit, it does offer an answer to the needs of operators having scattered operations who wish to handle their equipment with limited lease-trucking facilities, it is stated.

Unit Rig standard single-drum service-hoists can be used for pulling rods and tubing, and for bailing and swabbing. When it is necessary to fish, clean-out, deepen wells, or tail-in after rotaries, the U-19 Auxiliary Spudder Unit consisting of sand reel and spudder can be set in at the well and the single-drum service-hoist can be quickly connected to it, making a rigid combination double-drum spudder unit.

B. S. & B. Snuffer Valve Extinguishes Tank Fires

TO meet the requirements of customers who want to avoid fire hazard on tanks, Black, Sivalls and Bryson, Oklahoma City, Oklahoma, have perfected a new "snuffer valve," which is mounted on the flume or vent of the tank. The device, which is 20 in. in diameter, contains a lid held



open by a lever and link, the latter having a fusible joint that will melt quickly in case of fire, allowing the lid to drop shut. This operation cuts off the oxygen and automatically extinguishes the fire.

By removing the lever from the lid, the B. S. & B. Snuffer Valve can be used as a large hatch for tanks.

JOHN ZINK BURNERS

Manufacturer of

TROUBLE-FREE GAS BURNERS

"Install them and Forget them"

Not damaged by workmen walking on them
Not damaged by anything in the fuel line
Not damaged even by recent grasshopper plague in West Texas

Low in Fuel Consumption — Meter Readings Show Savings of 10% to 30%

JOHN ZINK BURNER CO., TULSA, OKLA.

Tulsa Plant—4401 South Peoria Avenue

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"TOLEDO" OPEN SIDE VISES

—are really fine quality, low-cost pipe vises.

Malleable iron frames. Heat treated steel jaws. Hardened vise screw. Large vise screw bearing. Extra long handle, giving ample leverage Construction of vise permits working close to face of vise. Excellent for fitting make-up work. Jaws are full over-lapping.

Made in three models: No. 00 holds ⅛" to 1½" pipe. No. 0 holds ⅛" to 2½" pipe. No. 3 holds ⅛" to 4½" pipe

FOR LARGE PIPE—

..We suggest a "TOLEDO" No. 9 or No. 18 Work Bench with chain vise. Chain is adjustable so that a single downward thrust of the controlling lever grips the pipe tight. Jaws are removable and have cut teeth and can be resharpened.

No. 9 holds 2" to 14" pipe.
No. 18 holds 2" to 18" pipe.

THE TOLEDO PIPE THREADING MACHINE COMPANY
TOLEDO, OHIO • NEW YORK OFFICE...72 LAFAYETTE STREET

"TOLEDO"
TRADE-MARK REGISTERED

YOU'LL DO BETTER WITH A "TOLEDO"

Telescoping Pipe Mast

THE Cardwell Manufacturing Company, Inc., Wichita, Kansas, is offering a telescoping pipe mast, 44 or 55 ft. in height when fully extended. This mast is mounted on a trailer that can be towed behind a truck and used with any servicing hoist. The mast is raised and extended by means of a manually operated winch. Purchase of the sheave at the bottom of the mast is optional but the sheave is desirable, if, because of fire hazard, it is necessary to operate the servicing hoist at some distance from the well. The mast can be raised and guyed, then the trailer removed.

The lower section of the mast is 8⅝-in. steel casing and the telescoping upper section is 7-in. steel casing, the ladder stirrups being on the lower casing. The upper section can be locked in a lowered or elevated position. Guy lines can be attached at the top of the lower section and at the top of the telescoping section.

Dempster Centrifugal Pump

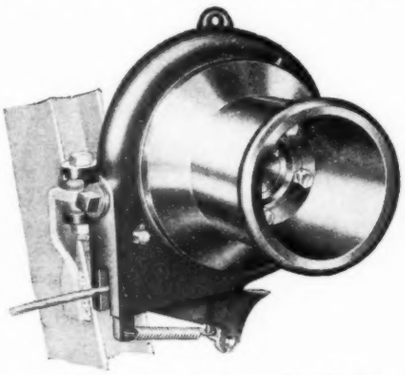
A NEW centrifugal pump for severe oil-field service, being particularly suitable for salt-water pumping, drainage, or other purposes involving corrosive or sediment-carrying waters; also suitable for clear water service, has been introduced by the Bovaird Supply Company, Tulsa, Oklahoma. Among the features of the pump are a special open-type impeller that is virtually self-cleaning, as it is fitted closely to

the back plate as well as the outside cover; an outside plate that can be removed if necessary to clean impeller or repair pump without breaking pipeline connections; equipped with Timken roller bearings and stainless steel shaft; end plate has "feeler" plug so that the impeller may be checked without taking the plate off.

These pumps are available on special order with impeller, outside plate, and wearing plate made of cast-alloy, bronze, or Everdur metal. A bronze-fitted or Everdur alloy metal-fitted pump is recommended for salt water or severe corrosive fluid service.

Improved Simplomatic Cathead

AN improvement of their Simplomatic Cathead is announced by the American Iron and Machine Works Company, Oklahoma City, Oklahoma, and Houston, Texas. The detachable spool may be removed when the width of the road or other conditions do not give clearance on the highway. Instead of having to remove the entire cathead from the drawworks, it is a simple



matter to remove the spool, which is made a part of the working mechanism of the cathead by a series of cap screws that may be easily removed and replaced.

Due to its improved engaging mechanism, the Simplomatic Cathead is equally adaptable to either fast or slow drawworks, it is stated.

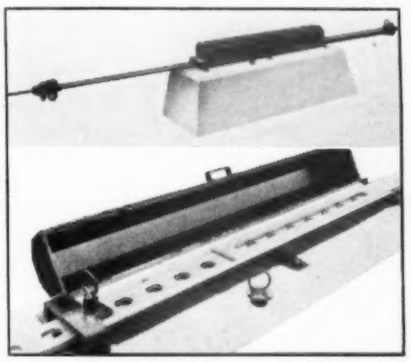
Four New Page Welding Electrodes

FOUR new welding electrodes called Page Surface Saving Electrodes have been added to the line manufactured by the Page Steel and Wire Division of the American Chain and Cable Company, Inc., Monessen, Pennsylvania. These electrodes are alloyed to meet the demand for tough abrasion-resisting materials for the original surface maintenance and repair of metal parts subject to excessive wear.

Page Surface Saving Electrodes all inter-alloy with the base metal when applied by the metallic-arc method. Four different electrodes are available, each having physical and chemical characteristics suiting them for particular needs. A comprehensive booklet is available from the manufacturer.

Allied Safety Type Knock-Off

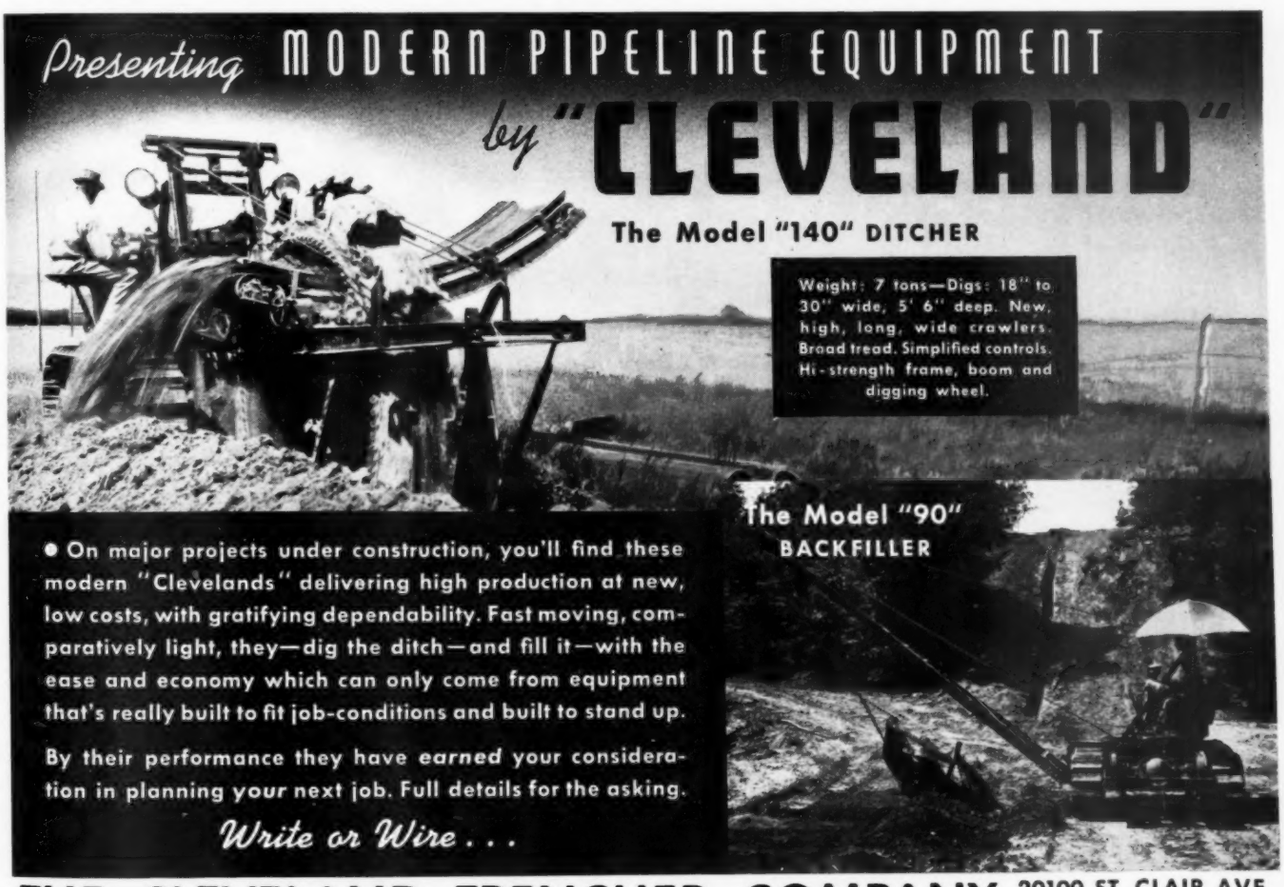
SIMPLICITY of design and safety of operation are the principal features of a new rod-line "knock-off" now available to the industry. The design is such that friction is held to a minimum, it is stated by the manufacturer. Hook-up is made by the use of



steel plugs for insertion through two sliding members that are enclosed by a safety steel hood.

The use of the Allied Safety Type Knock-Off eliminates "C" clamps, "C-C" clamps, one turnbuckle, knock-off block, knock-off hooks, and rod-line take-up jack, it is asserted. Two sizes are available: Type 9-80 for loads of less than 9,000 lb., and Type 16-80 for loads of less than 16,000 lb.

Descriptive literature will be sent to those interested by the Allied Steel Products Corporation, 1407-PE North Peoria Street, Tulsa, Oklahoma.


Presenting MODERN PIPELINE EQUIPMENT
by "CLEVELAND"
The Model "140" DITCHER
Weight: 7 tons—Digs: 18" to 30" wide, 5' 6" deep. New, high, long, wide crawlers. Broad tread. Simplified controls. Hi-strength frame, boom and digging wheel.
The Model "90" BACKFILLER
• On major projects under construction, you'll find these modern "Clevelands" delivering high production at new, low costs, with gratifying dependability. Fast moving, comparatively light, they—dig the ditch—and fill it—with the ease and economy which can only come from equipment that's really built to fit job-conditions and built to stand up.
By their performance they have earned your consideration in planning your next job. Full details for the asking.
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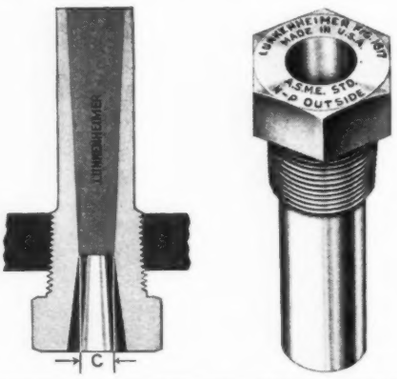
THE CLEVELAND TRENCHER COMPANY
20100 ST. CLAIR AVE.
CLEVELAND, OHIO

Lunkenheimer High-Pressure Fusible Plug

THE Lunkenheimer Company, Cincinnati, Ohio, has placed on the market a new extra-long, high-pressure fusible plug (Fig. 1617) for use on high-pressure oil-field boilers. It is inserted from the outside (fire side) of the plate or tube.

Each plug is stamped "A.S.M.E. Standard" on the bronze casing to signify that materials, design, and construction conform with A.S.M.E. Code specifications. A.P.I. Field Boiler Code requirements are the same as the A.S.M.E. Code.

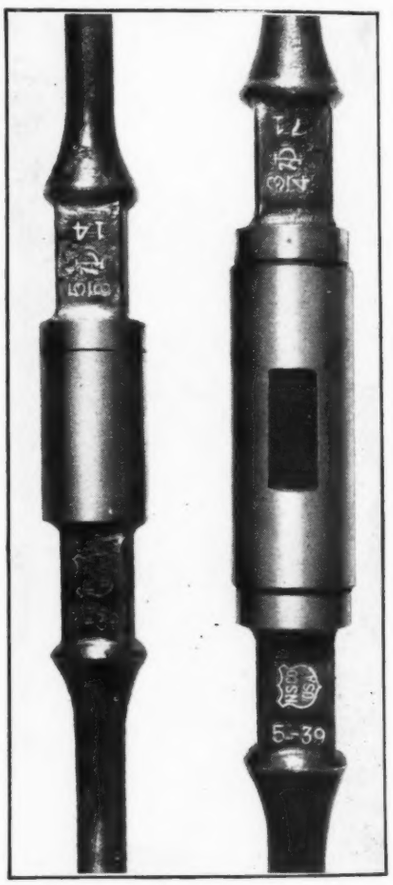
The casing of Fig. 1617 is bronze; the fusible core is pure Banca tin carefully alloyed to the casing. The extra-long construction insures the plug protruding into the water far enough to allow sufficient radiation of heat from the fire box and thus prevent the core from melting at high water level, the makers state. The plug, however, will actuate should the water drop below the safe low level, or if excessive foaming occurs at low water level, which might injure the crown sheet or tubes, it is asserted.



The long pipe thread of Fig. 1617 fits not only standard pipe threaded openings, but also openings that have been stretched oversize.

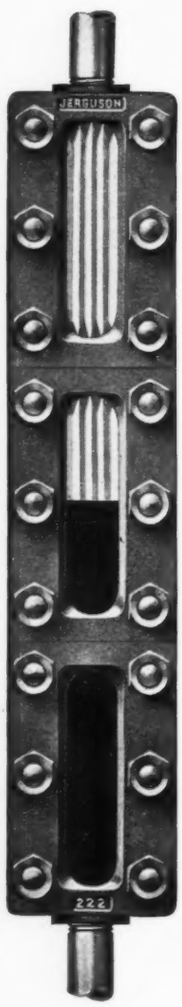
National Sucker Rods

NATIONAL SUPPLY Company, Toledo, Ohio, has added two new types of sucker rods to its line. The National Grade 14 Sucker Rod is made for use in non-corrosive areas where pumping loads are light and working stress does not exceed 20,000 lb. It is identical as far as material and manufacture are concerned with the National Grade 30 Sucker Rod except that it is not normalized.



The National Grade 71 is a chrome-nickel-alloy rod for heavy loads when corrosion is moderate and sulphides not severe. Under such definite but milder corrosive conditions, it can be used in place of the more expensive National Grade 81 rod, it is stated.

JERGUSON



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RUGGEDLY BUILT
FOR LONG SERVICE

Ideal for gasoline, kerosene, steam, oil, and other liquids. No matter what the color of liquid the

Empty space shows
WHITE

Liquid level appears
BLACK

Sensitive and accurate; not affected by external shocks or vibration. No adjustments needed. Safe at high pressures and temperatures. Easily read. Use Jerguson Transparent (thru vision) Gages when you need to show the color and density of liquids.

There's a JERGUSON GAGE for your plant.

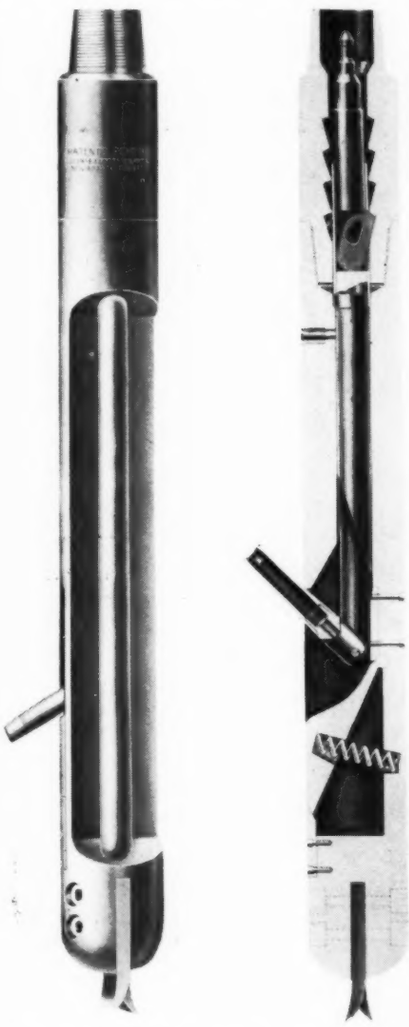
Jerguson Gages are best
By every real test.

Catalog on Request

JERGUSON GAGE & VALVE CO.
81 FELLSWAY
SOMERVILLE MASSACHUSETTS

Homco Side-Wall Sampler

HOMCO Cutting and Fishing Tool Service, a division of Houston Oil Field Material Company, announces a new method of taking and recovering side-wall samples, which, the manufacturer asserts, will considerably cut the amount of time required to complete a well by eliminating unnecessary coring. Any number of samples may be taken without interrupting normal drilling procedure, and the tool is designed to recover samples sufficiently large to make possible a complete analysis of the formation sampled. Cores 1¼ in. in diameter and 4 in. to 6 in. in length may be obtained in 8½ in. to 12¼ in. diameter holes, whereas 1⅛-in. cores, 4 in. to 6 in. in length,



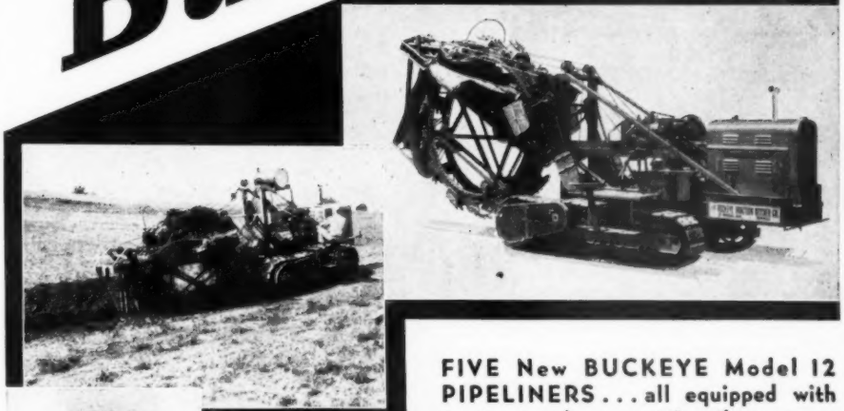
may be obtained in 7½-in. to 8½-in. diameter holes, the length of samples depending on the length of core tube used.

This tool, illustrated herewith in outside and inside views, is run on drill pipe and the sample is cut and recovered through drill pipe in connection with a wire-line retractable core barrel. Rotation and circulation of drilling fluid is permitted at all times, except when actuating the drill stem to obtain samples, by the use of a special circulation head having safety wire-line stuffing box.

The main body of the tool is attached to the drill stem and lowered into the hole to the desired depth. The coring assembly is lowered through the drill stem on the wire-line overshot assembly. When the lower section of the core barrel assembly, consisting of core and tube holder, comes in contact with the core tube deflector in the tool, the core tube is deflected through an opening in the tool into the side wall of the hole at an approximate 30-deg. angle, anchoring the tube in the formation. The coring assembly is locked in position by releasing the latching device in the top section of the coring assembly, and a ground seat is provided to prevent the assembly from passing too far through the tool.

As the drill stem is lowered slightly, the core tube is forced into the formation from the 30-deg. angle to the perpendicular of the tool through an angle of 90 deg. and finally comes to rest against the stop on the tool at a 45-

5 NEW Buckeyes
ON THE ST. LOUIS TO LIMA DITCH



FIVE New BUCKEYE Model 12 PIPELINERS . . . all equipped with tractor treads, are setting the pace on this important pipeline ditch.

Model 12 has the ruggedness, weight and power for those hard grinds often in almost solid rock, and it has remarkable speed for shallow ditches or deep ones in soft soils.

These fast, easily maneuvered machines are built with either gasoline or Diesel power. They dig trench 14½" to 24" wide and down to 5½ feet deep (or 30" wide, 5 feet deep). Trailers for quick transportation are available.

Wherever important pipe-lines are laid, Buckeyes dig the ditch. There are more Buckeye Ditchers in operation the world over than all other makes combined.

Model 12 is the most recent standard model for wide adaptability. It's a real money maker.

Originators of the wheel type DITCHING MACHINES

THE BUCKEYE TRACTION DITCHER COMPANY
FINDLAY, OHIO
MANUFACTURERS OF
CONVERTIBLE EXCAVATORS • BACKFILLERS • TRAILBUILDERS • SCRAPERS
BULLDOZERS • RIPPERS • TRACTOR POWER CONTROL UNITS

Please send complete information and prices on ☐ DITCHERS ☐ BACKFILLERS ☐ TRAILERS

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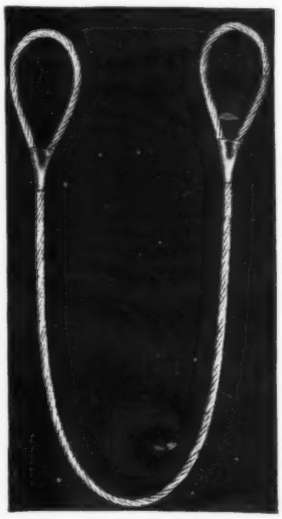
deg. angle. An upward movement of the drill stem returns the core tube to its original position, the assembly is unlatched from the tool, and retracted from the drill stem. Upon removal from the hole, the sample is removed, core tube replaced on the holder, and coring assembly is ready to repeat the operation.

All tools, subs, circulating head, overshot assembly, etc., necessary to the operation of the Homco Side-Wall Sampler, with the exception of the wire line and wire-line reel, are supplied to the user. These tools are available on a service basis in the United States and are for sale in foreign fields. The manufacturer will supply full details upon request to the home office in Houston, Texas.

Y-Guard Wire-Rope Sling

SAFETY to workmen's hands and higher efficiency are asserted for an improved loop-eye sling, called the Y-Guard sling, manufactured by Macwhyte Company, Kenosha, Wisconsin. Because of its patented tapered "Y-Guard" steel ferrule, it eliminates the protruding ends or wire seizing of the conventional eye splice, it is stated.



The wedge shaped "Y-Guard" steel ferrule streamlines the sling so it is easily pulled from under loads and makes it safer to handle.

This improved loop-eye sling is made of Macwhyte Preformed Whyte Strand (improved plow steel) wire rope. The loop eyes easily encircle crane hooks.

Dresser Announces New Super Service Fittings

DRESSER MANUFACTURING COMPANY, Bradford, Pennsylvania, announces a new line of Super Service Fittings for use on pipe to 2 in. Outstanding features, according to the manufacturer's announcement, are: extra heavy construction; reserve

sealing power for quickly making tight joints on undersized or corroded pipe; easy assembly on pipe already deflected; "stab" fit that makes disassembly unnecessary prior to installation.

The basic principle of the new fittings is similar to that of Dresser's bolted couplings, Style 38, except that threaded end-nuts, screwed on a threaded body, are used instead of

For
"ROUGH AN' TOUGH" drilling!...

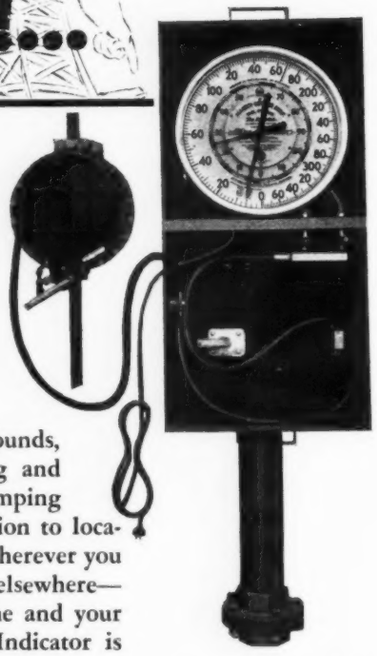
MARTIN-DECKER
"SEALTITE"
ASSEMBLIES

"Sealtite" means that your weight indicator leak problems are over.

The "Sealtite" Weight Indicator is direct reading, accurately showing the load in thousands of pounds, illuminated with indirect lighting and sealed up permanently so that no pumping or adjusting is necessary from location to location. Simply put the box on a post wherever you want it—in front of the driller or elsewhere—hang the diaphragm on the deadline and your "sealtite" Direct Reading Weight Indicator is in accurate dependable operation.

All copper tubing and copper tubing fittings have been completely eliminated from this hookup.

The entire assembly fits into the steel box when moving from location to location, but is ready for instant use for each succeeding location.



Your Quintuplex Weight Indicator can be "sealtited," also. Talk to the nearest Reed or Martin-Decker man.

Remember, no more pumping, no more leaks. Always ready. That's the Martin-Decker "Sealtite" Assembly!

HOME OF THE WEIGHT INDICATOR

MARTIN DECKER CORP.

LONG BEACH, CALIFORNIA

SAN JOAQUIN VALLEY: A. F. McQUISTON, BAKERSFIELD, CALIFORNIA
MID CONTINENT DISTRIBUTOR: REED ROLLER BIT COMPANY, HOUSTON, TEXAS

bolts to compress the resilient gaskets tightly around the pipe, sealing the joint.

By the use of the new Super Service Fittings, Dresser engineers state, a constant, positive flexibility is maintained that permits the pipe to ride with and absorb all normal pipe movements. This flexibility has been positively proved in the laboratory, where 694,583 continuous pipe deflections were made in a Super Service Coupling, at a pressure of 125 lb. per sq. in., through an arc of 4°, without pressure drop.

Other stated advantages are: plain-end pipe only required—no threading; pipe-ends have full strength—no reduced wall thickness necessary; one jointing tool only—a pipe wrench; anyone can install, even under water if required; safety is inherent; exact pipe lengths, tedious lining-up operations, large excavations are eliminated; a union-type connection is afforded; fittings can be salvaged, and an economical joint is provided.

Super Service Fittings are manufactured in a complete line of regular and long couplings, 45° and 90° regular ells, plain-end and threaded-end 90° street ells, and street tees; sizes ¾ in. I. D. to 2 in. I. D., inclusive.

Steel Swing Joints for Low Pressures

H AND B SALES COMPANY, Long Beach, California, has introduced a line of Champion Low Pressure Swing Joints, made for use in refineries and for the loading of fluid under pressure. These joints are

designed for use at pressures to 500 lb. They are designed for all types of loading operations where leak-proof operation is essential, and will handle fluid, steam, or gas without binding or leaking, the manufacturer states. Wherever free line movement is required, these joints will afford complete 360° rotation in one, two, or three planes, as desired, it is stated.

Champion Low Pressure Swing Joints are constructed of drop-forged steel castings. A brass wearing ring takes the pressure load and provides a smooth bearing surface for the swivel. The double swing joints are made of highest quality brass elbows and drop-forged swivel ends, which also turn on a brass bearing. Lubrication of all bearing surfaces is accomplished quickly and easily by fittings situated on the outside. The special composition packing resists action of acids, gases, and high temperatures, and may be replaced quickly and easily without removing the joints from the line, it is pointed out.

Champion Low Pressure Swing Joint bearings are easily serviced after long wear by refacing one side of the bearing ring, as in any split-type bearing. All joints are interchangeable on gas or fluid lines without changing packing. They are available in three types for all applications.

For further information write direct to H & B Sales Company, 2875 Cherry Avenue, Long Beach, California.

OVER 1000 WELLS ANALYZED WITH 93% Accuracy!!

Bayou Operation by Portable Field Laboratory

Our predictions for gas, oil and water productive strata for more than 1,000 wells, embodying over 38,000 feet of core from 108 fields, have been checked by actual production tests, and have been found to be over 93% correct.

This excellent performance record is the direct result of our broad background of proved core analysis procedures, experience and interpretations. Through this service, you actually know the type of production that will be obtained from each foot of formation analyzed.

One of these portable field laboratories is within quick driving distance from our base points to your well. Give us a call—our service is available 24 hours daily, including Sundays and holidays.

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Phones: 465 and 2054

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Phone 2900

Cotton Valley, Louisiana
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Lafayette, Louisiana
220 Simco Street
Phone 2060

Houma, Louisiana
513 School Street
Phone 1252

Hitchman Elected Chairman Appalachian Meter School

At the Second Annual Appalachian Gas Measurement Short Course held at the School of Mines, West Virginia University, Morgantown, West Virginia, August 21, 22, and 23, Ray W. Hitchman, superintendent of gas measurement or the United Fuel Gas Company, Charleston, West Virginia, was elected chairman of the school for the coming year.

This school, the first of its kind in the eastern United States and the third in the country at large, was voted most successful. Attended by more than 400 gas men consisting of representatives from 19 states, the District of Columbia, and Canada, the registrations showed a substantial increase over the 1938 meeting as well as a much wider geographic distribution. The interest in the papers read and discussed proved that the theme of the course, "Theory and Practice of the Measurement of Gases," is a subject that commands the attention of the entire gas industry. In addition to the prepared papers and formal proceedings presented, the numerous informal and unreported seminar classes conducted continuously throughout the three days' meetings were of the utmost interest and importance.

RAY W. HITCHMAN

The success of this school can be attributed largely to the efforts of Dr. C. E. Lawall, president of the University, assisted by Prof. G. R. Spindler and others of the School of Mines, and H. J. Wagner, the retiring chairman, and B. P. Stockwell, engineers of the Public Service Commission, together with the executives and engineers of the utilities and gas equipment manufacturers.

National Stripper Well Association to Meet October 17

The National Stripper Well Association, of which Jake L. Hamon, Dallas, Texas, is president, will hold its Annual Meeting in Fort Worth, Texas, October 17, 1939. The headquarters will be the Blackstone Hotel.

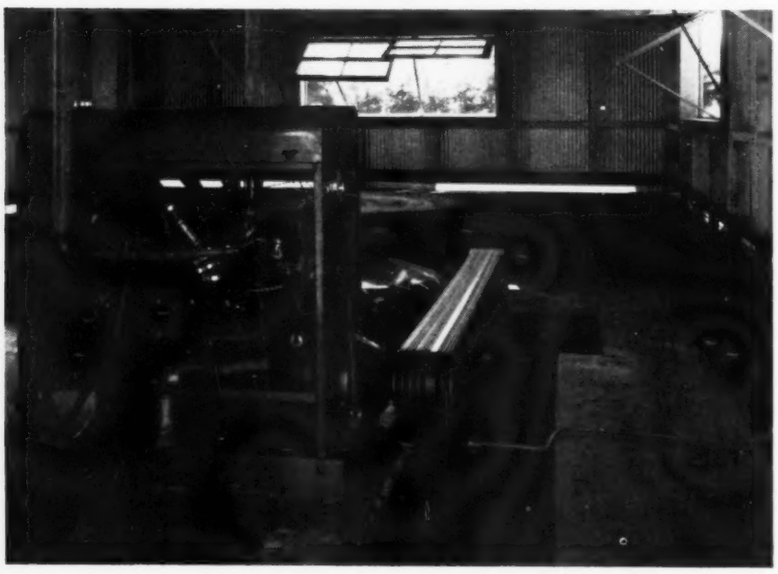
This meeting precedes by one day the opening of the Tenth Annual Convention of the Independent Petroleum Association of America, October 18, 19 and 20, at the Blackstone Hotel, Fort Worth.

Paul Cornelius to Mid-Continent Area

Appointment of Paul D. Cornelius to the staff of the Mid-Continent Division, in the capacity of sales engineer for Kobe Hydraulic All-Purpose Pumps, has been made by C. J. Coberly, president of Kobe, Incorporated, Huntington Park, California.

Active in the producing branch of the petroleum industry for a number of years, Cornelius has had wide ex-

General Power Pumps
1 well or 8 wells with Ease



G-P, T Series Unit

The G-P unit shown above is driving a gear type central power, pumping eight wells at St. Elmo, Ill. Natural gas fuel.

This compact, sturdy unit is designed for general applications. Uses latest type of Twin Disc clutch. Ford V-8, 85-hp. engine. Floor space, 27 in. wide, 49½ in. long.

All of the seven models of General Power conversion units are available with Ford V-8, 60 h.p., 85 h.p., 95 h.p., and Lincoln Zephyr engines. The natural gas models include flyball governor, combination carburetor, valve box, and gasometer type regulator. The nation-wide Ford repair and replacement service make these single, dual, and multiple engine units the economical power for drilling, pumping, and generating installations.

For Prices and Information — Write, Wire, or Phone

GENERAL POWER, INC.

QUAPAW, OKLAHOMA PHONE 64

PAUL CORNELIUS

perience in pumping operations and is well known throughout the Mid-Continent and Gulf Coast fields.

Although working out of the Mid-Continent Division offices at Oklahoma City, Oklahoma, under the direction of Division Manager C. M. Rader, Cornelius will make his headquarters at Kilgore, Texas, in order that he may be able to devote a large portion of his time to the company's activities throughout the East Texas territory.

G-E Advances Prout and Darcy

G. R. Prout has been appointed manager of sales of industrial control, and W. T. Darcy has been appointed manager of sales of renewal parts, according to a recent announcement by W. C. Yates, manager of the control and renewal parts division of General Electric's Industrial Department. The appointments were effective as of September 1.

G. R. PROUT

Prout, who until his recent appointment has been acting manager of the southwestern district for the company's Industrial Department, is a native of Quincy, Massachusetts. He is a graduate of Massachusetts Institute of Technology, having degrees of B.S. and M.S. in electrical engineering. He entered General Electric's small motor department at Lynn, Massachusetts, in 1923 and the following year was transferred to the company's southwestern district. His new headquarters will be Schenectady, New York.

Darcy is a native of Bridgeport, Connecticut. He went with General Electric in July, 1925, joining the testing department in Schenectady. After two and one-half years of this training, he was transferred to the renewal parts section of the industrial department and, since that time, he has continued in this particular type of work. From May, 1928, to April, 1934, he was temporarily located at various of the company's plants, including Bloomfield, Schenectady, and River Works at West Lynn, as well as the Cleveland office. He returned to Schenectady in 1934 and since last year has served as assistant to W. C. Yates in charge of renewal parts sales.

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Kinzbach Tool Company Announces Changes

C. W. EICHBAUM, JR.

JUDSON McCANN

Kinzbach Tool Company, Houston, Texas, announces new territorial changes in the company's sales and service staff in line with a recent expansion program. Charles W. Eichbaum, Jr., who represented Technical Oil Tools, Ltd. for 2½ years, is being transferred by Kinzbach from Houston to the South Texas district. Eichbaum, a graduate mechanical engineer from the University of California, has been working in the oil country since 1927, and joined the Kinzbach sales and service staff early this year.

Judson "Doc" McCann, who joined the organization in August, has been named South Louisiana representative. For the last 6½ years McCann has been with Union Sulphur Company, and previously represented the Layne-Louisiana Company.

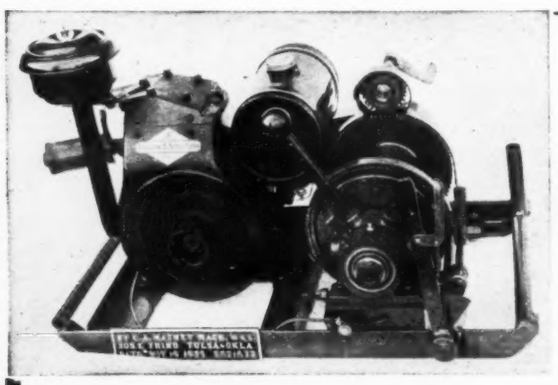
E. M. Smith Takes Globe Management

Announcement that E. M. Smith, founder and former president of Emsco Derrick and Equipment Company, will continue to be active in the manufacture and distribution of oil-well tools in the capacity of general manager of Globe Oil Tools Company, Los Nietos, California, will be news of interest to his many friends throughout the petroleum industry.

Smith began his career as a salesman in the California oil fields in 1907. During the ensuing 30-odd years of his activities he has organized more than a score of companies. Globe Oil Tools Company is one of the companies organized by him during that period, being a consolidation of three manufacturers of drilling, coring, and reaming tools. Among the present line of Globe tools is the Globe Type "H" rock bit, manufactured with four different cutter assemblies for digging a wide range of formations; the Globe box and pin type drilling bits, produced in five drag types and one fluid section type for use in formations that can be cut with the circulation fluid; and the original but improved W-K-W type bits. In addition to these, several new items have been developed during the last few years, which will be announced in the near future.

For many years Smith has been a world traveler, having personally visited virtually every active oil field in the world. Although his executive duties with the Globe company will require his presence at the company's headquarters a good portion of the time, he will continue as in the past to spend as much time as possible in the field.

The company now has branches in Houston, Oklahoma City, and Casper, whereas all export business in handled through the New York office at 30 Rockefeller Plaza. Coincidentally with the announcement of his active participation in the affairs of the Globe company, Smith states that the company shortly will launch an aggressive campaign of distribution that will make Globe tools quickly available to even the remotest field or well.



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Capacity, 6,000 feet of .066 line. Ball-bearing equipment throughout. Special type clutch prevents sudden jolt on line and drum when power is applied. Besides regular combination clutch and brake the unit has an extra emergency brake.

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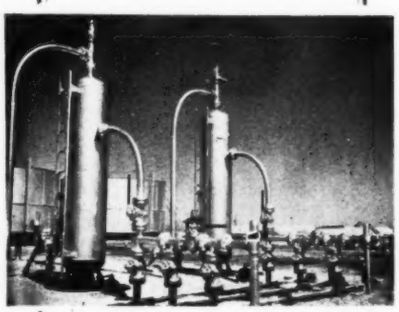

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Bruce Barkis and K. A. Wright Form New Company

Bruce Barkis and Kenneth A. Wright have formed a new firm known as B and W, Inc., to manufac-

BRUCE BARKIS

ture and distribute oil-well specialties, featuring equipment for mud removal and sand control. Headquarters of the company are at 3545 Cedar Avenue, Long Beach, California.

George S. Watson, Jr., Killed in Car Accident

George S. Watson, Jr., salesman for the McEvoy Oil Well Equipment Company, Houston, Texas, died September 4 from injuries received in a car accident near Lubbock, Texas, the

GEORGE S. WATSON, Jr.

previous Saturday. He was 24 years of age.

Watson suffered a compound fracture of both legs, a fractured jaw, bruises and lacerations when his car smashed into the rear of a parked wheat truck seven miles southwest of Lubbock.

George S. Watson, Sr., is vice-president and general manager of the McEvoy Oil Well Equipment Company.

Surviving are his parents, three brothers, Searcy, Robert, and Thomas, all of Houston, and his grandmother, Mrs. Elizabeth Watson, of Dallas.

Capt. A. E. Higgins Makes Series of Flying Trips

Captain A. E. Higgins, vice-president in charge of sales for Pittsburgh Equitable Meter Company and Merco Nordstrom Valve Company, recently made a series of flying trips throughout the country. Piloting his own plane, Captain Higgins has found that he can cover several thousand extra miles of traveling to keep in close contact with the various offices of his organization from the Pacific to the Atlantic.

During recent weeks he has been on the Pacific Coast conferring with executives of various petroleum companies, gas corporations, and public utilities.

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Pumping wells, capable of producing more fluid than their allowables will permit, require a pump tailor-made for just such service. Because the income from such wells is restricted, the expense of operating them must be kept at a minimum.

In wells of this type, the service conditions are not difficult, so low initial investment in pumps is perfectly in keeping with economical operation.

The O'Bannon Pump which is ideal for such installations is appropriately named the Thrift Rod Pump. It is for the thrifty producer who wants to keep his operating expenses at a minimum.

The initial investment required for the O'Bannon Thrift Rod Pump is low, and, when compared with the service this pump is capable of, it is found to be remarkably lower.

The efficiency of this all-metal, precision pump is due entirely to the fine materials and care used in its manufacture. A two-cup extension on the plunger is optional. The plunger standing valve (to prevent gas lock) and a three-cup Turnproof hold-down are standard equipment.

To meet all requirements, it is furnished in two sizes: 2" x 1½", 2½" x 2"; and in three lengths for strokes of 32", 44" and 68".

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O'BANNON
THRIFT ROD PUMP

Machine Tool Show Cancelled

Because of the outbreak of the war in Europe, the members of the National Machine Tool Builders' Association decided to postpone indefinitely the Machine Tool Show that was to have been held at Cleveland, Ohio, October 4 to 13. This also involves the postponement of the Machine Tool Congress, a series of meetings sponsored by a group of nine engineering and technical societies, and which were to have been held during the Machine Tool Show.

E. J. Daly Transferred

E. J. Daly, who has been stationed at New Orleans, Louisiana, for the Wickwire Spencer Steel Company, has been transferred to Houston, Texas, to take charge of the company's sales in the Texas Gulf Coast area, as well as Louisiana. His headquarters will be at 10 Milby Street.

Johnston Acquires Osgood Sub-Surface Pressure Survey Service

M. O. Johnston Oil Tools, Inc., Los Angeles, California, has acquired the sub-surface pressure survey service conducted by Commander W. H. Osgood, former retired naval officer who has been recalled to active duty. It is planned to expand this service.

The Johnston bottom-hole pressure recorder, which is run in conjunction with the Johnston formation tester, obtains the first possible record of pressures in a newly exposed sand in a drilling well, officials of the company point out. The sub-surface pressure survey service offers the operator a means of continuing that pressure record after the well's completion by periodic runs throughout its economic life. Instruments are available for use in flowing, gas-lift, or pumping wells.

New instruments are now in the course of development in Johnston's laboratory and will be added to this service from time to time, it is announced. One of these will serve as a check on the depth pressure record obtained on each run to insure maximum accuracy of results. Others, which will serve to measure various physical properties of well fluids, will be announced in the near future.

Smith Precision Products Company Formed

The Smith Precision Products Company, 1135 Mission Street, South Pasadena, California, has been organized by R. Stanley Smith and associates, including Thomas M. Penny, who has been appointed sales manager.

The new company will manufacture several specialties for application in the sales and production divisions of the oil trade, production having already

R. STANLEY SMITH

been started at the Smith plant on a new type of rotary pump that Smith has had under development and test over a period of years and which is said to be particularly adapted for pumping gasoline and butane.

Smith is perhaps best known to the oil industry through his development and manufacture of Smith meters. His

THOMAS M. PENNY

former company, the Smith Meter Company of Los Angeles, was purchased by the A. O. Smith Corporation of Milwaukee about two years ago. Since that time, and until recently, Smith has been in charge of what was known as the South Pasadena Research Division of the A. O. Smith Corporation.

Penny, formerly with Smith Meter Company of Los Angeles and later with the Smith Meter Division of the A. O. Smith Corporation, was branch manager for Smith meters successively at Chicago, Houston, and Denver.

Tulsa Oil Show Exhibit Space 72 Percent Sold

The International Petroleum Exposition, to be held in Tulsa, Oklahoma, May 18 to 25, 1940, has already issued contracts to exhibitors for 72 percent of the available exhibit space, according to an announcement by President W. G. Skelly. The report is the first available since August 15, which was set as a deadline on the option granted 1938 exhibitors to renew their former space.

"Telegrams, letters, and long distance phone calls poured into our offices during the last several days before the option expired," Skelly said, "and General Manager Wm. B. Way and his staff have just completed an up-to-date analysis of space sales."

The report stated that of the 165,338 sq. ft. of outside exhibit space, a total of 132,432 sq. ft. has already been reserved; and 363 of the 685 booths in the five huge exhibit buildings already have been taken.

A total of 201 contracts have been issued as against 442 last year; however, 136 other exhibitors, who have asked for a change in location or for additional space, have made reservations and contracts will be issued as fast as the desired accommodations can be provided. These reservations do not include space requested by more than 50 firms who have never before exhibited. These firms will be given contracts as soon as the changes requested by former exhibitors under their options are made.

General Manager Way reports that the option deadline was set a month earlier this year to allow exhibitors ample time in which to prepare their displays.

Way said that the trend is no longer for exhibitors to throw together an exhibit in a few weeks.

"Rather than plan an exhibit carelessly," he said, "many of the larger exhibitors plan the contents of their exhibits from six to nine months ahead."

Two of the larger exhibitors have already sent representatives from their home offices to survey the grounds and lay plans for elaborate working models in their exhibits.

"This is the earliest period in the history of the exposition that 72 percent of the space has been reserved," President Skelly said, "and that 72 percent has been found to consist of more pace than was sold for any of the first nine expositions."

The eleventh exposition in 1940 will be as big as the 1938 show, and if demands continue to come in for large exhibit tracts, the grounds used as a park south of the cafeteria will be turned into additional space.

Interest in the exposition from foreign countries is great in spite of the war situation, especially since the oil-producing nations were issued special invitations to attend the oil show by the United States Department of State and by officials of the exposition.

John B. Tua, member of the Italian consulate organization in the United States, who visited Way recently, was the first representative of a government in the history of the oil show to be sent to check up on the show in advance. Tua was to report back to his government on the advisability of sending a large delegation of technical experts to the next show.

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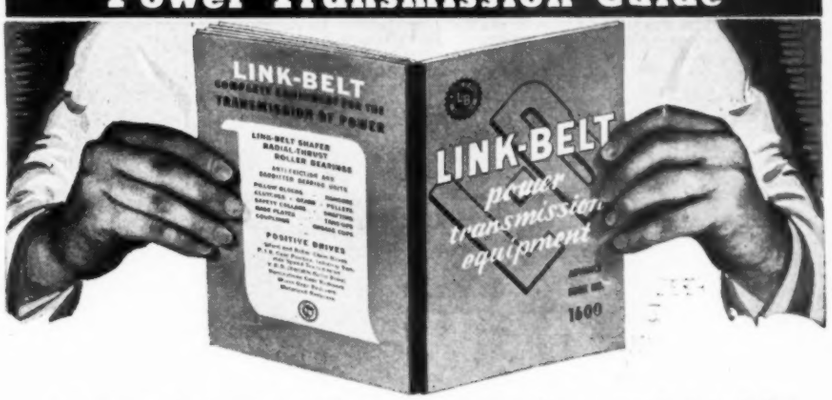

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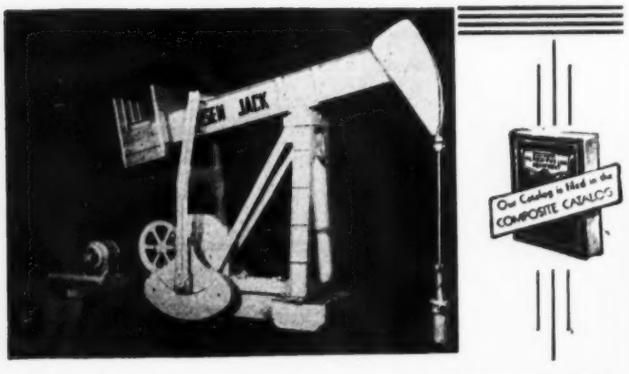

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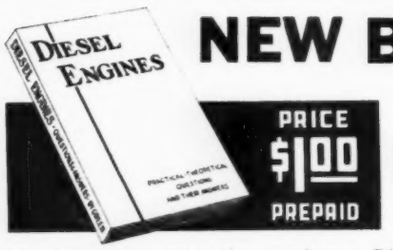

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Paul T. Putnam Passes Away

PAUL T. PUTNAM

Paul T. Putnam, advertising and sales manager for Cameron Iron Works, Houston, Texas, died August 15 at Corpus Christi, Texas, after a brief illness. Burial was in Houston.

Putnam was well known in the petroleum industry, his association with it in one capacity or another having extended over a period of approximately 14 years.

He was born in Whitefish Bay, Wisconsin, 45 years ago and moved with his family to Houston in 1907. He was on the staff of the Dallas News in 1916-17, leaving to attend officers' training camp and serving as lieutenant in the 33rd Aero Squadron during the World War.

In 1925, Putnam joined the staff of the W-K-M Company, Houston, to do advertising and sales work, later being made manager of the specialty sales division. He resigned that post to enter business for himself as representative of several manufacturers. He was on the sales staff of the *Oil and Gas Journal* in 1934-35, becoming associated in the latter year with Cameron Iron Works as advertising manager. He was promoted to sales manager in 1938.

Putnam's two surviving brothers are identified with the petroleum industry. Thad Putnam, New York City, is an export agent, and Walter Putnam is with the Shell Oil Company at McCamey, Texas.

1939 "Petroleum Facts and Figures" Issued

The 1939 sixth edition of "Petroleum Facts and Figures," a 192-page fact book covering operations of the petroleum industry in all its branches, has been published by the American Petroleum Institute's Department of Public Relations. The new edition brings up-to-date all data in the 1937 fifth edition, and adds approximately 50 new or completely revised tables. As far as possible, all usable new data available to August 1, 1939, are included.

Because so large an industry creates voluminous data, reflected in the large number of new tables, the sixth edition supplements rather than supplants the previous edition. Time-series tables from the fifth edition are continued for years subsequent to 1933, with page references to prior data in the fifth edition.

The 215 tables in the sixth edition are distributed under seven chapter headings: utilization, production, refining, transportation, marketing, prices and taxation, and general. All tables, as nearly as possible, are in logical order under each chapter, to make the book in large measure self-indexing. A complete subject index, however, makes it easy to find specific facts.

In addition to the tabular material, important petroleum-industry lists are given in an appendix: directors, officers, and complete committee roster of the American Petroleum Institute; list of government petroleum statistical and regulatory agencies; a directory of petroleum and allied associations; a directory of petroleum-company house organs; and a list of publications of the American Petroleum Institute.

Copies of the sixth edition, paper-bound and illustrated by pictorial statistics, are available from American Petroleum Institute, New York. Price of the new edition is $1.

H. W. Fletcher Named General Manager Hughes Tool Company

H. W. Fletcher, chief engineer for the last 22 years, has been named vice-president and general manager of the Hughes Tool Company, Houston, Texas, to succeed the late Stanley P. Brown. Fletcher joined the Hughes organization in 1917 as chief engineer and continued to occupy that position until his recent promotion.

Fletcher was born in Brooklyn, New York, 48 years ago. He graduated from Cornell University in 1915, and immediately became connected with the Newark Spring Mattress Company. Later he was an engineer with a construction company.

He became acquainted with Howard Hughes, Sr., in 1916 when the latter was working on an invention to bore horizontally beneath a trench for the purpose of planting a charge of explosive. His idea was highly considered by army officials, who believed it would revolutionize trench warfare. Fletcher was introduced to Hughes by a mutual friend to assist in this work and it was as a result of this acquaintanceship that Fletcher joined the Hughes Tool Company as chief engineer in 1917.

Martin-Decker Appoints New Mid-Continent Salesman

Martin-Decker Corporation, Long Beach, California, has announced that Dave Waters, formerly with Reed Roller Bit Company at Shreveport, Louisiana, has been appointed salesman for Martin-Decker products in Illinois, Kansas, and Oklahoma.

DAVE WATERS

Waters is a graduate of the University of Alabama, has had four years' field experience with the Humble Oil and Refining Company, and for two and a half years has been a member of Reed Roller Bit Company's sales staff at the Shreveport branch.

Waters is now at Martin-Decker's main plant at Long Beach, learning design, assembly, and operation of Martin-Decker oil-field instruments, and expects to be in his new territory within a few weeks.

Allis-Chalmers Announces Changes

Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, has established a new branch office at Louisville, Kentucky. W. E. Kercheval is in charge.

A new branch office also has been established at LaPorte, Indiana. B. L. Margeson, formerly in charge of the company's Rockford, Illinois, office, is in charge.

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D-10 packing resists corrosive effects of Hydrogen Sulphide, Sulphur Dioxide and organic compounds found in petroleum, both crude and in process of refining.

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FULTON Spring-Type REGULATOR

EASILY transported, easily installed, self-protecting against accident or meddlers, you'll often find the Fulton Spring-Type Regulator preferable to one of the lever type for use in exposed, out-of-the-way places. Designed for high-pressure service as here shown, reduces from 300 pounds to any pressure between 10 and 50 pounds. Designed for low-pressure service, reduces inlet pressures as high as 50 pounds to outlet pressures of one pound or under. Full information given in Bulletin 118, mailed on request.

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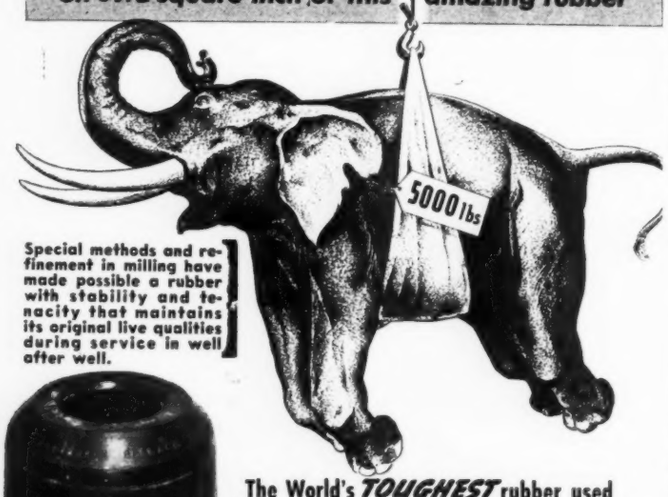

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Merla Tool Company Incorporates

The Merla Tool Company, Dallas, Texas, has been incorporated as a Texas corporation with a capitalization of $40,000. The firm name has been changed to the Merla Tool Corporation.

The corporate structure dissolved the co-partnership that had been in effect since 1934. The new corporation acquires all assets of the co-partnership and assumes all liabilities incurred by the several partners.

The directors of the new corporation are D. W. Henke, C. S. Crickmer, Roy A. Lamb, Hans C. Glitsch, and Fritz W. Glitsch, Jr. The officers are D. W. Henke, president and general manager; C. S. Crickmer, vice-president in charge of engineering; Roy A. Lamb, vice-president in charge of sales; Hans C. Glitsch, vice-president in charge of materials and inspection; Fritz W. Glitsch, Jr., vice-president in charge of manufacturing; V. A. Kagay, secretary and treasurer, and George O. Wilson was elected as general counsel.

All the officers as well as other personnel of the new corporation have had many years experience in the oil industry. D. W. Henke first entered the oil industry in 1916 when he joined S. A. Guiberson, Jr., in California, moving later to Dallas. He was assistant treasurer of the Guiberson Corporation from 1920 to 1929 and secretary and treasurer from 1929 to April 1, 1939, when he resigned to join the Merla Tool Company.

C. S. Crickmer was chief engineer of the Guiberson Corporation until May, 1934, when he joined the Merla Tool Company.

Roy A. Lamb joined the Guiberson Corporation in 1928 as a member of the engineering department in the Dallas office. In June, 1935, he joined the Merla Tool Company as sales manager.

Fritz W. Glitsch, Jr., served an apprenticeship in the machine shop of Fritz W. Glitsch, Sr. He also spent three years as a student engineer with the General Electric Company, Schenectady, New York. He joined the Merla Tool Company as a partner in 1936.

Hans C. Glitsch, from 1927 to 1928, was a student engineer with General Electric Company. A year later he studied job analysis, methods, and planning for General Electric and from 1929 to 1930 was an instructor of industrial engineering. He has been associated with the Merla Tool Company as a partner for the last four years.

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**Petroleum Engineer Editorial, Midyear, 1939*

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9 Rockfeller Plaza New York City

Book Reviews

Handbook of Chemistry and Physics, Charles D. Hodgman, Editor-in-chief. 23rd edition, 1939. Published by Chemical Rubber Publishing Company, 1900 West 112th Street, Cleveland, Ohio. Deluxe edition, $6.00 in U. S. and Canada; $6.50 elsewhere.

In the new edition of this authoritative source of basic data pertaining to chemistry and physics, its useful form has been retained in making certain important revisions and additions. The table "Physical Constants of Inorganic and Metal-Organic Compounds" has been completely revised to include a substantial amount of new information concerning compounds already listed and new compounds have been added to the list. The table "X-Ray Crystallographic Data" has been wholly revised and new material added. In addition to material of former editions, the following features have been added: Melting Point Index of Organic Compounds; Boiling Point Index of Organic Compounds; Potentials of Electrochemical Reactions; Free Energy; Ionization Potentials; Ratio Tables for Bridge Calculations.

* * *

Diesel Engines—Practical and Theoretical Questions and Their Answers. Written and published by Lewis F. Green, M. S., 663 Chamber of Commerce Building, Los Angeles, California. Price: $1.00 per copy.

In a clear, interesting question-and-answer form, this book deals with the maintenance and operation of Diesel engines and provides a vast fund of pertinent information for those who may occasionally be called upon to "shoot trouble."

The writer is well qualified to prepare a book of this type having studied Diesel engine design and construction under the eminent Professor Collier at Friedrichashafen University, Germany, and obtained much valuable experience on the research staff of Packard-Diesel motors. He has the distinction of having installed, tested, and maintained the first Diesel engine to be used in a Stinson plane, this plane now being exhibited in the Ford Museum. His book should prove valuable to all who have any contact with Diesel engine operation or who are interested in becoming more familiar with the terms, developments, and peculiarities of Diesel power.

* * *

Standard Chemical and Technical Dictionary by H. Bennet, 1939. Published by Chemical Publishing Company, Inc., New York, New York. 637 pp. Price, $10.00.

This book very definitely fulfills the need for a source to which technical as well as non-technical men may turn for definition of technical terms with which they may not be conversant. More than 25,000 definitions are included touching upon virtually every branch of technical and scientific endeavor. Of particular value are the sections on Nomenclature of Organic Chemistry, Prefix Names of Organic Radicals, and Pronunciation of Chemical Words.

Returns from Western Trip

C. K. Stillwagon, president, Well Equipment Manufacturing Corporation, has recently returned from a three weeks' trip through the Pacific Coast and Rocky Mountain territories. In Los Angeles he conferred with Petroleum Equipment Company, Weco distributors in California fields; in Seattle he appointed Olympic Supply Company as representatives in the states of Washington and Oregon, and in Denver appointed C. E. Strong, Jr., as representative, selling through supply companies in the Rocky Mountain territory. Strong is in the Continental Building, Denver.

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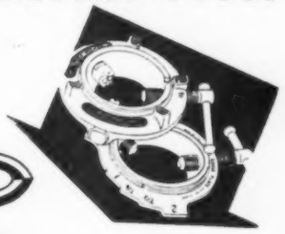

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W.P.R.A. Regional Technical Meetings

Various phases of refining developments will be treated in the two regional technical meetings of the Manufacturing Committee of the Western Petroleum Refiners Association to be held in Wichita, Kansas, and Shreveport, Louisiana, next month, according to the announcement by L. D. Mann, chairman of the Manufacturing Committee.

The Wichita meeting has been scheduled for October 5, 10 a. m., at the Allis Hotel, and the Shreveport meeting will be October 27, 10 a. m., at the Washington-Youree Hotel. The following subjects will be discussed:

Wichita, Kansas:

"New Developments in Burners and Their Application," by Edwin L. Dennis, chief combustion engineer, Coppus Engineering Company, Worcester, Massachusetts.

"Fuels and Lubricants for Farm Tractors," by C. G. Krieger, agricultural engineer, Ethyl Gasoline Corporation, Detroit, Michigan.

"Catalysis in Oil Refining," by Universal Oil Products Company, Chicago, Illinois.

Shreveport, Louisiana:

"Inhibitors for Cracked and Polymerized Gasolines," by W. W. Scheumann, Cities Service Oil Company, Tulsa.

"Copper Treating of Petroleum Products," by Charles Wirth, Universal Oil Products Company, Chicago, Illinois.

The third paper will be announced later.

Demonstration of tube rolling at Arkansas Fuel Oil Company refinery, by Key Company, East St. Louis, Illinois.

Tretolite Patent Held Infringed

The United States Circuit Court of Appeals for the Ninth Circuit has affirmed the United States District Court for the Southern District of California in the oil patent case, Tretolite Company v. Research Products Company, Ltd., holding that the latter company, by making and selling a chemical reagent known as "Hydrate 488" for recovering crude petroleum oil from emulsions, had infringed the patent of the Tretolite Company. The case, which has been pending nearly six years, involved a patent obtained by William S. Barnickel, a pharmaceutical chemist of St. Louis. Filed in 1933, the case was originally tried in 1935 before U. S. Commissioner David B. Head, sitting as special master, in Los Angeles. His decision, that the patent was valid and infringed, was sustained by U. S. Judge Harry Hollzer last year.

During the trial of the case it was developed that crude oil valued at more than a billion dollars had been recovered by means of the chemical reagents used in the process of the patent; and that the process was being employed in South America, Mexico, Roumania, and other foreign countries, in addition to nearly every oil field in the United States.

Los Angeles Basin Chapter A.P.I. Meets

The Los Angeles Basin Chapter of the Division of Production of the American Petroleum Institute held its September meeting on September 12 in the Shell Oil Company Recreation Hall, Long Beach, California.

The program included the following: "Recovery of Iodine from Oil Field Waste Waters," by M. F. Ohman, of the Dow Chemical Company. J. P. Bailey, the Standard Oil Company geologist, who has had many colorful foreign experiences, talked on "The Exploration of Mahakam River Basin, Borneo." Bill Pemberton supervised the showing of his very interesting color picture on "Condors."

MEETINGS

West Virginia Oil and Natural Gas Association, Annual Meeting—September 27 and 28, Charleston, West Virginia.

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 4, 5, and 6, Galveston, Texas.

California Natural Gasoline Association — October 5, Richfield Building, Los Angeles, California.

Western Petroleum Refiners Association, Regional Technical Meeting—October 5, Allis Hotel, Wichita, Kansas.

Texas Mid-Continent Oil and Gas Association, Annual Meeting—October 5, 6, and 7, Houston, Texas.

American Gas Association, Annual Convention—October 9 and 10, New York, New York.

National Safety Congress and Exposition—October 16, 17, 18, 19, and 20, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

National Stripper Well Association—October 17, Fort Worth, Texas.

Independent Petroleum Association of America, Tenth Annual Meeting—October 18, 19, and 20, Fort Worth, Texas.

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 19 and 20, Los Angeles, California.

Western Petroleum Refiners Association, Regional Technical Meeting—October 27, Washington-Youree Hotel, Shreveport, Louisiana.

American Petroleum Institute, 20th Annual Meeting—November 13, 14, 15, 16, and 17, Stevens Hotel, Chicago, Illinois.

American Institute of Chemical Engineers—November 15, 16, and 17, Providence, Rhode Island.

American Society of Mechanical Engineers—December 4, 5, 6, and 7, Philadelphia, Pennsylvania.

American Association of Petroleum Geologists, Annual Meeting—April 10, 11, and 12, 1940, Stevens Hotel, Chicago, Illinois.

American Petroleum Institute, Eastern District, Division of Production—April 11 and 12, 1940, Columbus, Ohio.

National Petroleum Association, Semi-Annual Meeting—April 18 and 19, 1940, Cleveland Hotel, Cleveland, Ohio.

International Petroleum Exposition—May 18, 19, 20, 21, 22, 23, 24, and 25, 1940, Tulsa, Oklahoma.

Third World Petroleum Congress—June 9, 10, 11, 12, 13, 14, and 15, 1940, Berlin, Germany.

Stanolind Makes Organization Changes

Several changes were made as of September 1 by the Stanolind Oil and Gas Company. Pat Darney was transferred from Cayuga to Spring Hill, East Texas district, to be replaced at Cayuga by C. J. McCrory from the Carlisle district. McCrory is being succeeded at Carlisle by Fred Born of the Overton district.

Appoint Export Manager, Distributor

Lloyd G. Ensign, 30 Rockefeller Plaza, New York City, has been appointed export manager for the Line Scale Company, Inc., Oklahoma City, Oklahoma. Appointment of the Brown Oil Tool Company, Inc., Houston, Texas, as exclusive Gulf Coast distributors also is announced by the manufacturers of Line Scales.

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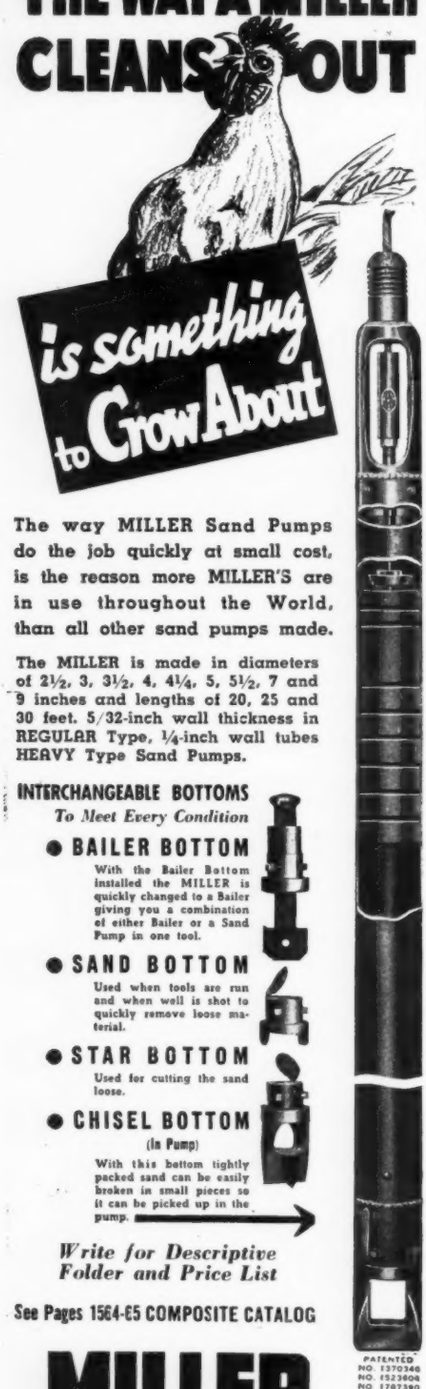

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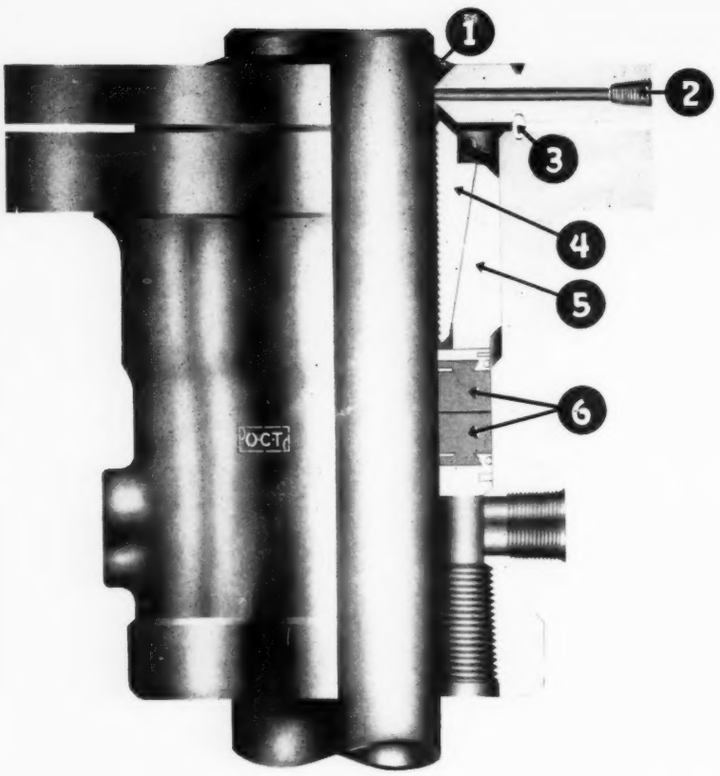
In order for
you to get the utmost in Speed, Dependability and Economy when treating crude oil to pipe line requirements it is necessary that the treating formula be developed in the most scientific manner. Recognized as the pioneer in this work, for many years Tretolite formulas and their method of development have been considered by the industry as the standard of comparison.
TRETOLITE COMPANY
Manufacturing Chemists
DALLAS ST. LOUIS LOS ANGELES
Representatives in All Principal Fields

You Can't Go Wrong With This

If You Want:

- ✓ Slip Suspension of Casing
- ✓ Welded Seal of Annular Space
- ✓ Means of Testing the Weld
- ✓ API Ring Seal Between Flanges



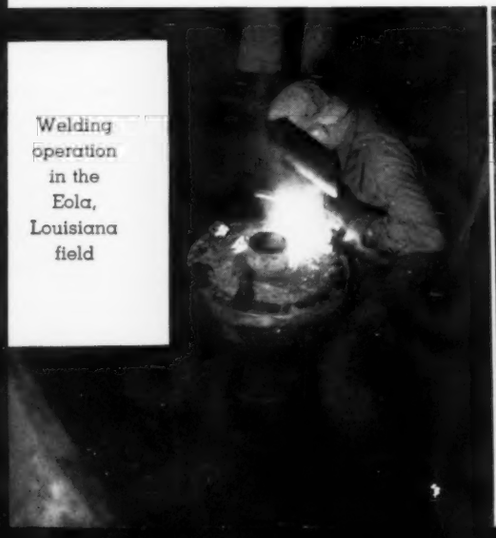
Reference to Figures Above: (1) Weld, (2) Hydraulic pressure port, (3) A.P.I. ring gasket, (4) 3-segment slips, (5) Split slip bowl (6) Neoprene packing assembly.

THIS O-C-T Type "C-9-C" Casing Head has got everything it takes to safely suspend and seal casing strings. Slip suspension permits landing casing at any desired point and enables the operator to suspend the casing with the desired amount of tension, without backing out the top joint and nippling up. Two heavy rings of neoprene packing provided below the slips effect a seal the instant pipe is suspended on the slips, weight of the casing being utilized to compress the packing around the pipe. After casing is suspended, the top joint is cut off approximately one foot above top of casing head, preventers are then removed and welding flange slipped over casing and welded to same. Then to make sure that the weld is pressure-tight, hydraulic pressure is applied between the weld and the neoprene seal through a port in the welding flange. (Testing apparatus and testing operation illustrated below.) Thus, the annular space is sealed below the slips, and the weld provides an auxiliary seal above the slips as well as a means of preventing the pipe from moving either upward or downward. An A.P.I. ring gasket seals between flanges. The welding flange is also grooved on top for an A.P.I. ring gasket to seal between blowout preventers, another casing head, or tubing head.

The O-C-T Type "C-9-C" Casing Head, which is available in test pressures up to 10,000 lbs., is but one of a large number of thoroughly proven O-C-T Heads. A catalog of the complete line of O-C-T high pressure control and completion equipment will be sent on request.

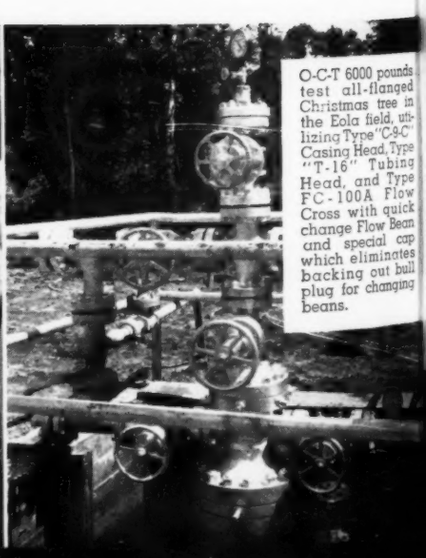
WELD TESTING APPARATUS

Here is the simple apparatus for testing the weld in conjunction with O-C-T Type "C-9-C" Casing Heads. Its total weight is only 12 lbs. An O-C-T field representative will gladly demonstrate the testing method, which requires about 10 minutes of one man's time. Weld testing kits are priced nominally and can be bought through leading supply stores.



Welding operation in the Eola, Louisiana field

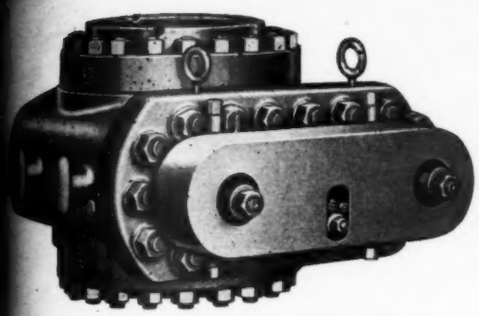
Testing the weld. Note 2500 lbs. pressure on gauge



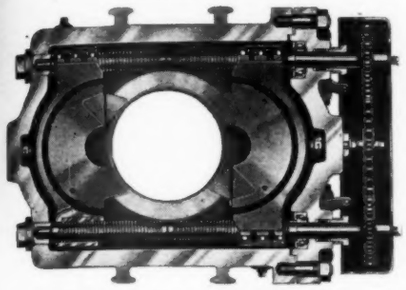
O-C-T 6000 pounds test all-flanged Christmas tree in the Eola field, utilizing Type "C-9-C" Casing Head, Type "T-16" Tubing Head, and Type FC-100A Flow Cross with quick change Flow Bean and special cap which eliminates backing out bull plug for changing beans.

SHAFFER ROLL CALL

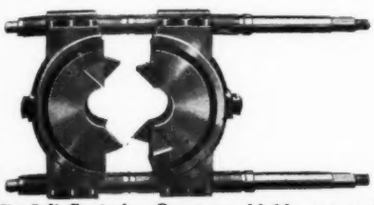
OF NEW & IMPROVED CONTROL EQUIPMENT For 1939



The Shaffer Type 38 Cellar Control Gate has new features of strength and safety which you should review.

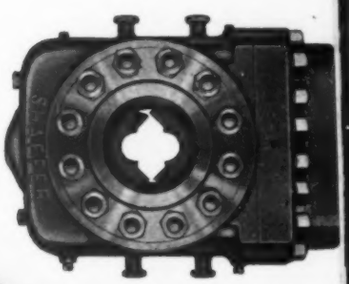


New rigid construction of the Ram Assembly provides perfect alignment and easier opening or closing.



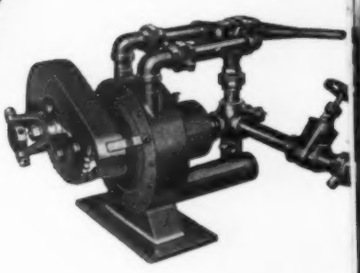
The Self Centering Rams are highly successful for centering small diameter drill pipe in large bore gates.

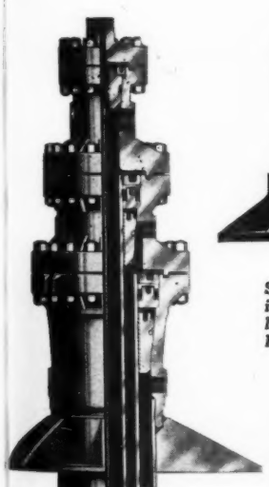
The 10,000-pound test Shaffer Cellar Co Gate is the latest development for contr extremely high pressures.

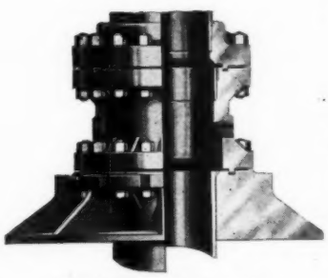


Illustrating Self Centering Rams in tially closed position in the 1 pound test gate, to provide pre control never before available

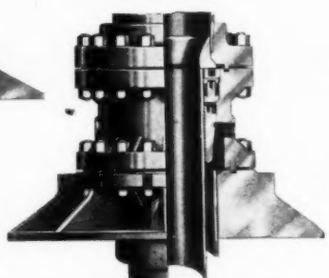
COMPLETE DETAILS ARE IN THE COMPOSITE CATALOG STARTING ON PAGE 2009 . . . . OR ASK FOR YOUR COPY OF THE SHAFFER CATALOG FREE ON REQUEST







Showing the "full opening" before casing is landed through a Shaffer Full Opening Spool-Type Landing Head.



Drilling is carried on through Shaffer Full Opening Spool Type Landing Heads; each casing string is individually landed and packed off against highest pressures.

Casing landed, showing method of individual suspension and packing off of each casing string.

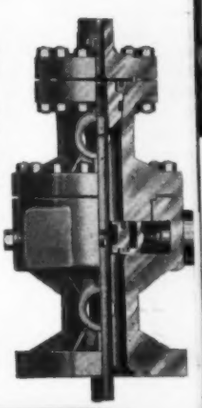
Don't Forget
SHAFFER FISHING TOOLS
They Work!

SHAFFER TOOL WORKS

BREA, CALIFORNIA
California Service Shops
Santa Fe Springs, Taft and Ventura
HOUSTON, TEXAS — 6006 Navigation Blvd.
OKLAHOMA CITY, OKLA. — ACME OIL TOOL COMPANY, 1001 S. E. 29th St.

EXPORT SALES OFFICE:
Shaffer Tool Works,
30 Rockefeller Plaza, New York, N.Y., U.S.A.

The new Shaffer Gate Closing Steam Engine should be on every Shaffer Cellar Control Gate; it is easily attached and provides the maximum in fast, effortless closing or opening of the gate.



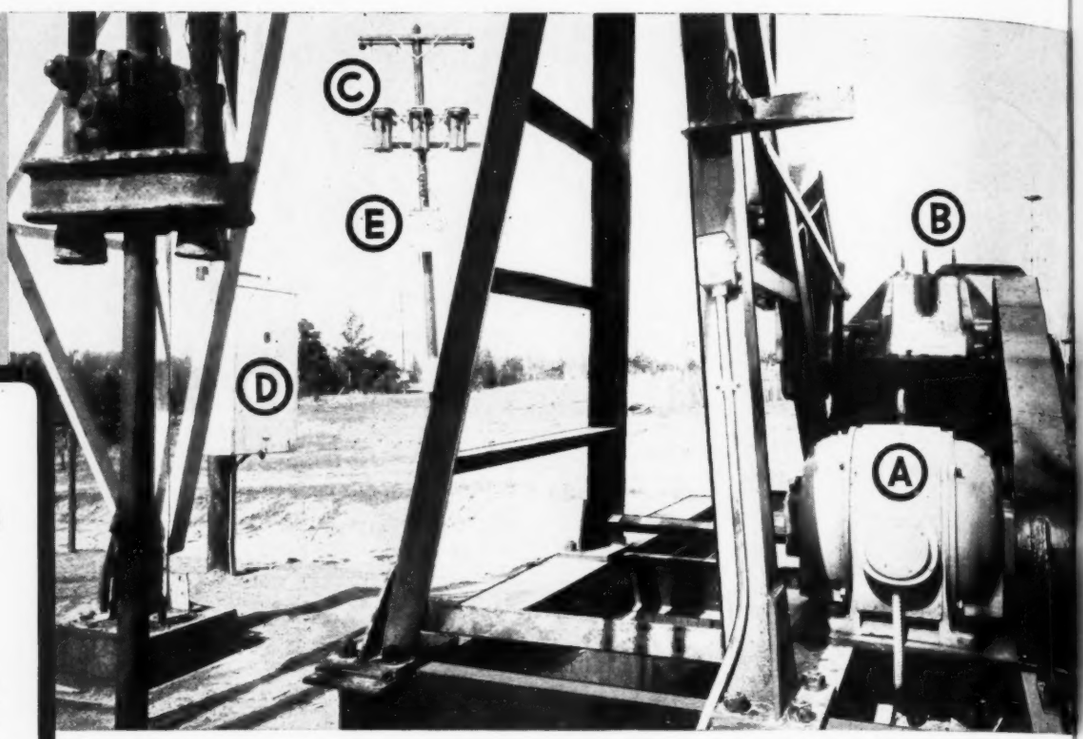
There is no danger of blow-outs when drilling and tubing a well equipped with a Shaffer Universal Tubing Control Head.

SHAFFER

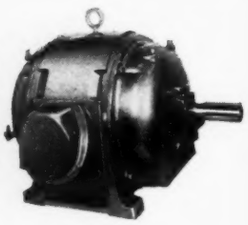
HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT
FISHING TOOLS THAT EXCEL
Described in detail on Pages 2009 to 2044 of the 1939 COMPOSITE CATALOG

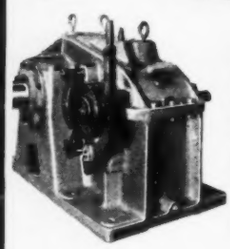
5 BIG BENEFITS FROM PUMPING ELECTRICALLY

Pumping rigs completely equipped with Westinghouse drives, like the one illustrated, are delivering day-in-and-day-out performance in every oil field. They stand up and take it under most severe weather conditions.



)15 HP SPLASH-OOF MOTOR— ectrical parts otected against lashing liquids id moisture. Es- cially suitable r outdoor in- allations.





(B) OIL PUMPING UNIT—double reduction oil pumping speed reducer with double extended slow speed shaft for single or twin-crank pumping.

(C) 3-10KV-A CSP TRANSFORMERS—completely self-protected against lightning, service interruptions from fuse outages, and burnouts from short circuits and overloads.

(D) 15 HP WEATHERPROOF CONTROL.

(E) POLE MOUNTED CAPACITOR— for power factor correction.

Electrically driven equipment for oil well pumping, when powered by Westinghouse, offers these important advantages:

1. Simplified operation through automatic starting, pumping and stopping.
2. Less down time and lower service costs by elimination of winter freezing and starting troubles.
3. Longer life of pumping equipment because of "softer drive."
4. Lower investment and installation charges, elimination of buildings, fuel service and water cooling tanks.
5. Low depreciation and maintenance on Westinghouse weatherproof electrical equipment.

Obtain these benefits by using Westinghouse electric drives for your next pumping installation. Our local office will give you complete data — and expert "back-up" support is available at headquarters when needed. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Penna.

J-94135

Westinghouse

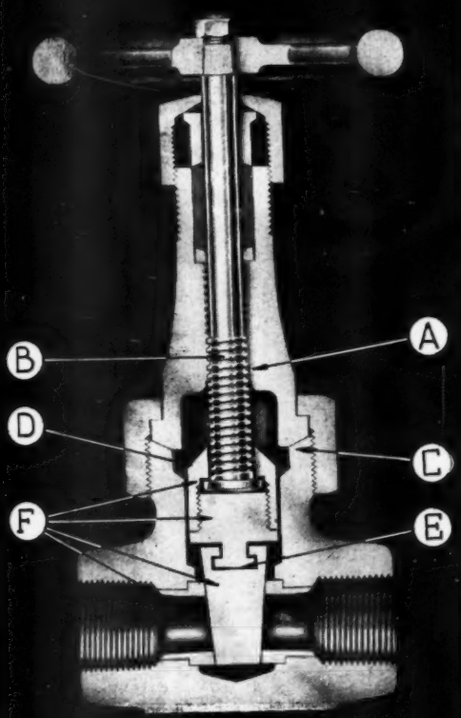
WESTINGHOUSE ELECTRIC

ELECTRICAL PARTNER OF THE PETROLEUM INDUSTRY

and now the new
Inside Screw · Rising Stem

FORGED STEEL GATE VALVE

Chapman
LIST 960



A—All Threads Inside the Valve
B—Quick Acting Threads
C—Ball Joint Connection
D—Full Pressure Repacking
E—Flexible Stem Connection
F—Replaceable Stainless Steel Parts

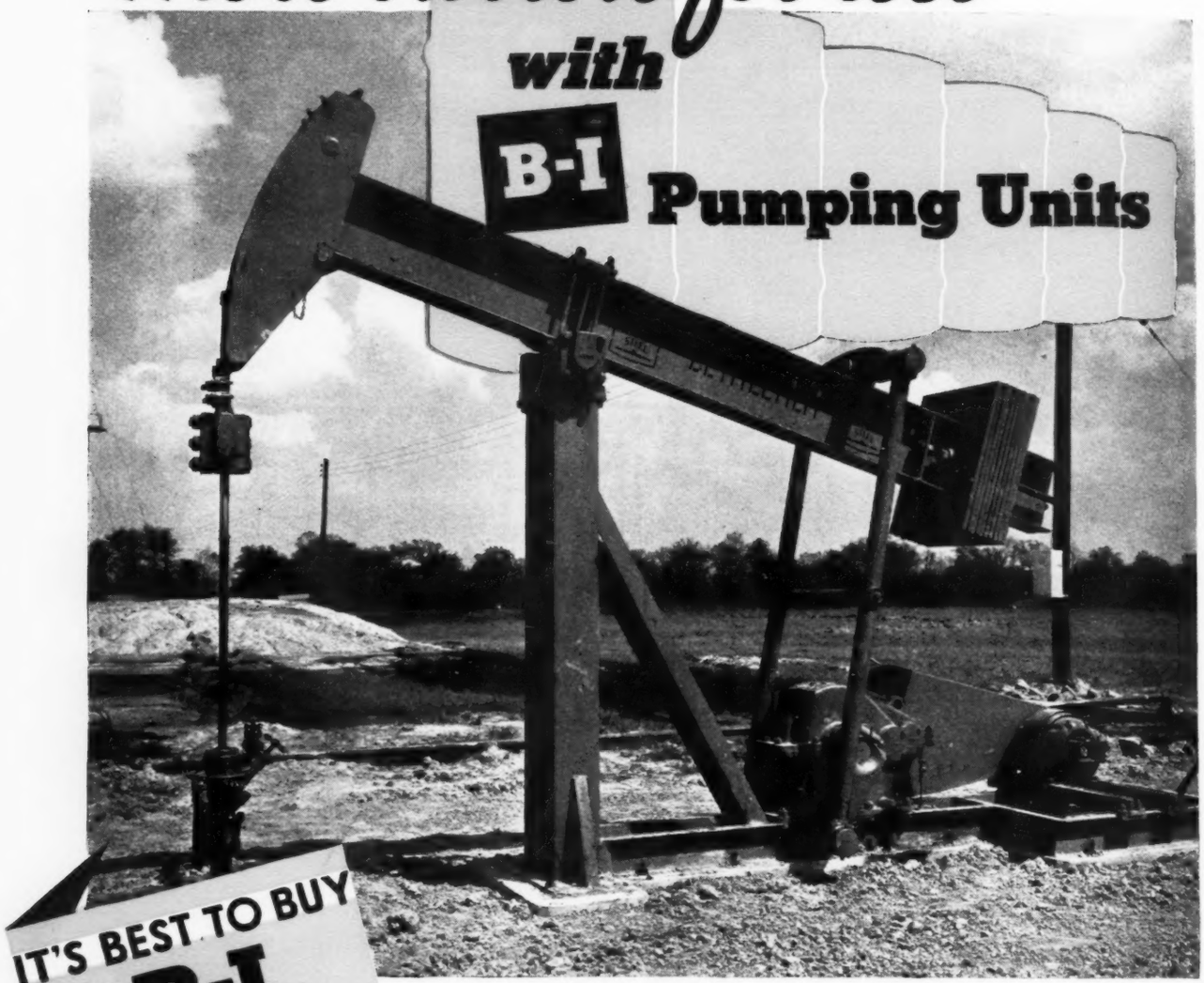
This new *inside screw* model has been added to our List 960 line of forged steel gate valves. Perfected to the last detail for long, hard and efficient service, this new valve is a fit mate for the *outside screw* model which has been so successful in all types of small valve service. Both models have forged steel bodies and stainless steel, interchangeable parts.

LIST 960 is made in all sizes from ¼" to 2" inclusive, with screw ends for threaded pipe. Suitable for all pressures up to 800 lbs. at 750 degrees F., or cold working pressures to 1500 lbs. Built for long, trouble-proof service under the most severe conditions, they challenge comparison with valves of any other type for real economy.

Outside Screw Model Chapman List 960 Steel Gate Valve

THE CHAPMAN VALVE
MANUFACTURING COMPANY
INDIAN ORCHARD, MASS.

More barrels for less with B-I Pumping Units



IT'S BEST TO BUY B-I

A few cents saved in bringing each barrel of oil above ground may make a big difference in the success of your operations. So it's good business to select a Bethlehem-International Pumping Unit of the right size for your well. That's the way to pump more barrels at less expense.

Built for economy—B-I Pumping Units are designed to combine strength and weight so that initial cost is low and operating expense is at a minimum. Rigid frames, sturdy sampson posts of all-welded construction, strong pitmans, conservatively rated walking beams, straight-lift polished rod hangers, adjustable counterbalances, forged steel gears on large alloy steel shafts mounted on roller bearings in cast iron gear cases, are neatly assembled into attractive pumping units that are highly efficient and fully capable of getting maximum fluid pumped at minimum cost.

Service in making a selection—Bethlehem-International makes it easy for you to find the pumping unit best suited to your needs. If you provide a description of well-operating conditions, a trained B-I representative can quickly show you a unit of the capacity you want at the Bethlehem-International store nearest you. You'll be surprised at how little it costs to own a B-I Pumping Unit.

If you haven't a complete knowledge of your well conditions, B-I engineers and technical instruments are available to help you make a survey of your well.

Call **BETHLEHEM-INTERNATIONAL** for Service

BETHLEHEM-INTERNATIONAL SUPPLY COMPANY

Subsidiary of Bethlehem Steel Company

Main Office: Tulsa, Oklahoma

No wonder they all like *Performance Proved*

SUPERINTENDENT
"Wire Line Maintenance Costs Going Down? S-W-E-L-L! That means you're using Macwhyte PREformed . . ."

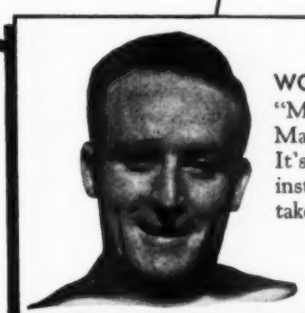
PURCHASING AGENT
"I buy on the basis of quality and service . . . That's why I buy Macwhyte PREformed."

MACWHYTE PREformed

FOREMAN
"We've speeded up our production schedule since we started using Macwhyte PREformed . . . fewer shutdowns for replacements now."

FEWER REPLACEMENTS . . .
BETTER OPERATION . . .
SAVINGS IN MAINTENANCE . . .
SPEEDED-UP PRODUCTION . . .
all are possible when you buy high quality wire line*

(P. S. Have you Tried This Laboratory Tested, Field Proved, BETTER Wire Line?)



WORKMAN
"Me? I like to work with Macwhyte PREformed. It's easy to handle and install . . . and it sure can take it!"

Macwhyte wire line, famous for its long life and low cost, is better today than ever before!

LONG SERVICE

Macwhyte steels are better today . . . laboratory tests are more exact . . . workmen are more skilled and experienced . . . field tests are constantly proving and improving the right line for the specific job.

Yes, you're assured of economical service from Macwhyte wire lines.

AT LOWER COST

And you get it at lower cost, too. For example, the famous special Macwhyte internal lubrication protects Macwhyte lines from corrosion, makes them easy to handle, cuts down internal friction . . . which naturally increases service life . . . lowers cost.

LESS WEAR ON MACHINERY

In addition, the special PREformed construction allows the line to run smoothly, easily over sheaves and drums . . . with a minimum of wear on the machine and the line.

Is it any wonder that there are more Macwhyte users today than ever before?

**There is no better wire line than Macwhyte PREformed*

These distributors will give you quick service:

Baldwin Supply Co., Charleston, W. Va.
Branchland Pipe & Supply Company, Paintsville, Ky.
Bradford Supply Company, Bradford, Pa., Ill., Ky., Mich., Ohio, Okla., Pa., Texas, and W. Va.
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WIRE LINES

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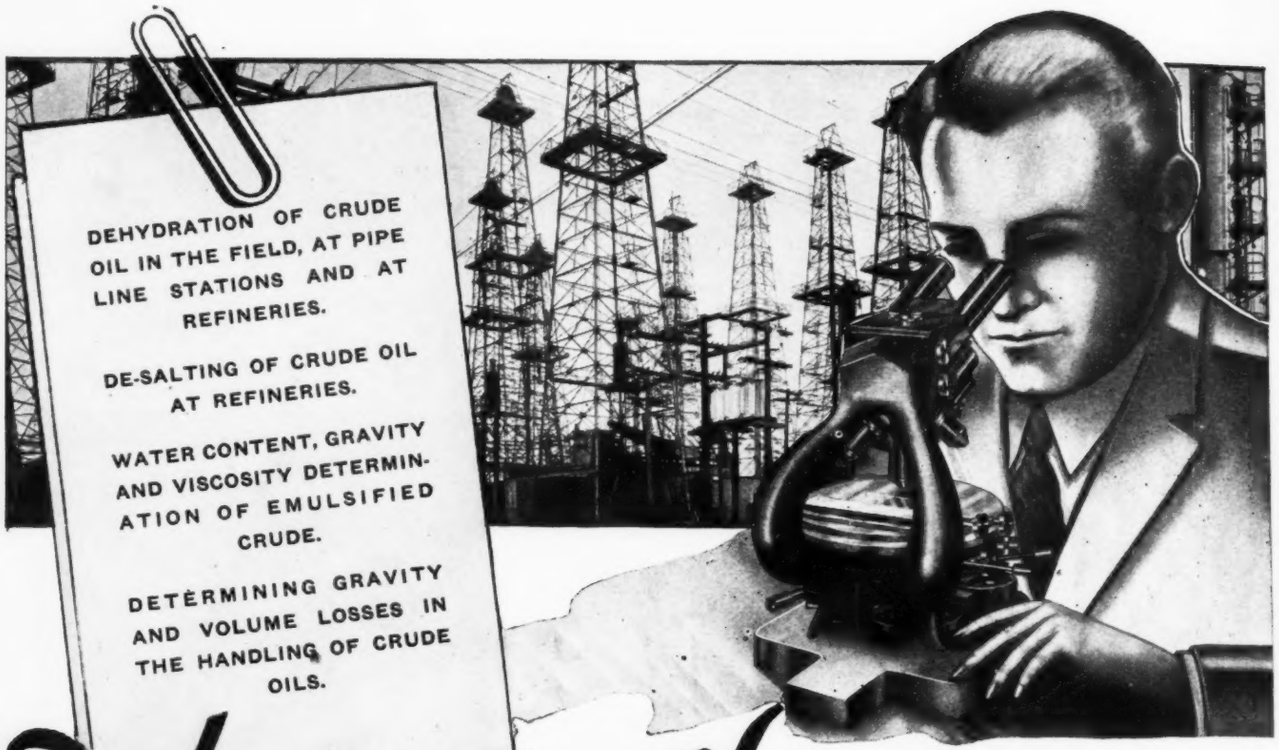

DEHYDRATION OF CRUDE OIL IN THE FIELD, AT PIPE LINE STATIONS AND AT REFINERIES.

DE-SALTING OF CRUDE OIL AT REFINERIES.

WATER CONTENT, GRAVITY AND VISCOSITY DETERMINATION OF EMULSIFIED CRUDE.

DETERMINING GRAVITY AND VOLUME LOSSES IN THE HANDLING OF CRUDE OILS.

METHODS AND PROCEDURE IN GAUGING AND SAMPLING EMULSIFIED CRUDE.

WATER AND OIL ANALYSES.

BALLAST WATER SEPARATING PROCESS

GAS-TAR EMULSION PROBLEMS.

CONSULTATIONS AND INVESTIGATIONS OF SPECIAL DE-EMULSIFICATION AND SEPARATING PROBLEMS.

DISSEMINATION OF TECHNICAL INFORMATION RELATING TO OIL EMULSIONS.

Dehydration Headquarters

Due to noteworthy success in this specialized field, Petreco long has been recognized as the leading authority on emulsified crude. The scope of Petreco's activities is indicated by the wide range of services rendered to all branches of the petroleum industry, a few of which are enumerated here. Petreco's comprehensive advisory service is available to oil companies everywhere, and preliminary consultations or investigations involve no obligation whatever. For dependable information on de-emulsification problems come direct to Dehydration Headquarters.

PETROLEUM RECTIFYING COMPANY OF CALIFORNIA
General Offices: 530 West Sixth Street, Los Angeles, California
Gulf Coast Headquarters: Houston, Texas
Representatives in Principal Oil Fields and Refining Centers

OWNERS OF THE

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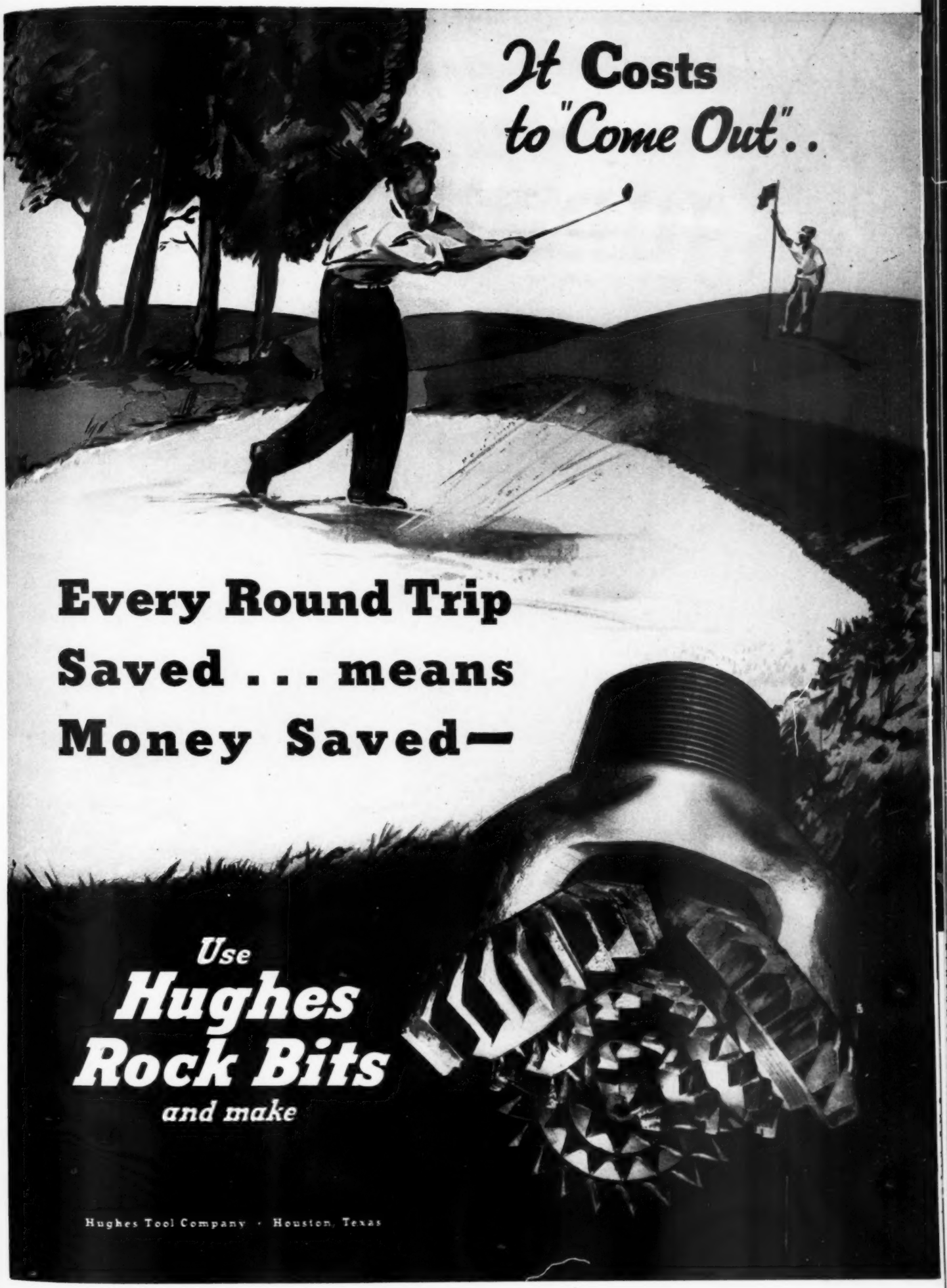
Electromatic


It Costs
to "Come Out"..
Every Round Trip
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Use
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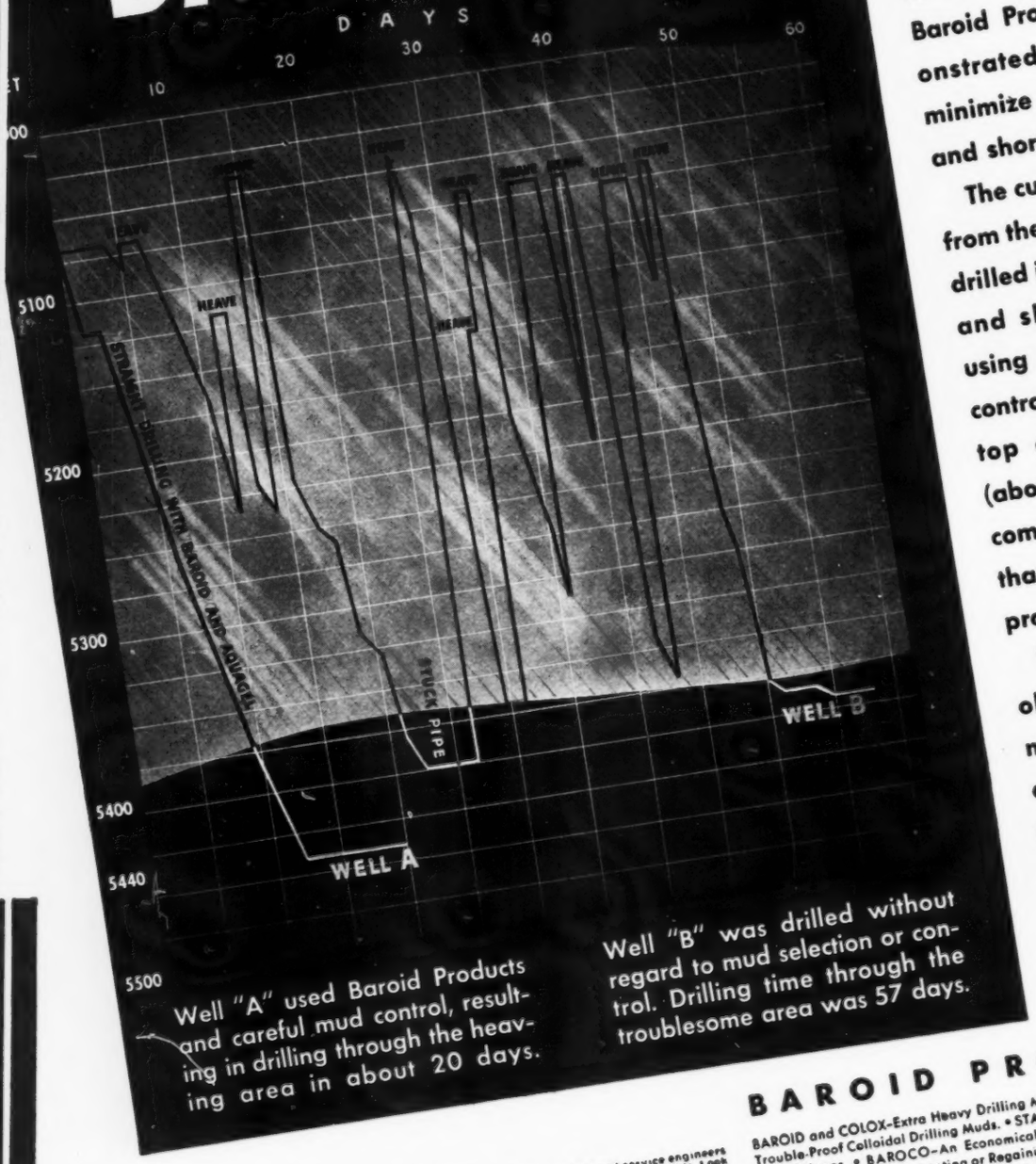
Straighten Out your drilling curve with BAROID PRODUCTS



Well "A" used Baroid Products and careful mud control, resulting in drilling through the heaving area in about 20 days.

Well "B" was drilled without regard to mud selection or control. Drilling time through the troublesome area was 57 days.

In wells all over the world, Baroid Products have demonstrated their ability to minimize drilling difficulties and shorten drilling time.

The curve at left was made from the records of two wells drilled in a troublesome area and shows that Well "A" using Baroid Products and control was drilled from the top of the heaving area (about 5040 feet deep), to completion in 37 days less than Well "B" on which other products were used.

This is typical of the results obtained by operators in many fields and proves the advantages of the proper selection and control of drilling mud.

Stocks carried and service engineers available in all active oil fields. Look for this trade mark under "Oil Well Drilling Mud" in your classified telephone directory for our nearest service engineer and distributor.

BAROID PRODUCTS

BAROID and COLOX-Extra Heavy Drilling Muds. • AQUAGEL and JELOX-Trouble-Proof Colloidal Drilling Muds. • STABILITE-An Improved Chemical Mud Thinner • BAROCO-An Economical, Salt Water-Resisting Drilling Clay. • FIBROTEX-For Preventing or Regaining Lost Circulation. • AQUAGEL for CEMENT-For setting casing and restoring lost circulation. • SMENTOX -For Reconditioning Cement-Cut Muds. • ZEOGEL-Special Clay To Be Used As A Suspending Agent When Salt or Salt Water Are Encountered. • TESTING EQUIPMENT-For drilling mud analysis and control.

BAROID SALES DEPARTMENT

NATIONAL PIGMENTS & CHEMICAL DIVISION OF
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BAROID SALES OFFICES • LOS ANGELES • TULSA • HOUSTON

HOW WOULD YOU RECLAIM TOOL JOINT ?

HERE'S ONE METHOD WITH LINCOLN ARC WELDING

Courtesy of Oil Field Machine & Supply Co., Houston, Texas

BOX END Standard drill pipe with A.P.I. joints. Joints are machined about 1/4" to receive semi-circular medium-carbon steel build-up clips as shown. Edges of clips are bevelled to provide greater weld penetration.

SET-UP Wheel on right clamps on end of joint for turning pipe while welding. Copper back-up clamp on left provides a wall against which weld metal builds up, assuring flat surface for contact with elevator in handling pipe at the well.

WELDING Initial passes, welding clips to joint, made with 5/16" "Fleetweld No. 5" Electrode, providing exceptionally high strength. Finish passes made with "Wearweld" Electrode, providing high resistance to impact and abrasion.

PIN END Joint is first tightened, then fillet welded to the pipe as shown with "Fleetweld 5" Electrode, providing a joint that is permanently pressure-tight and well reinforced at the last engaged thread. This joint is then the strongest part of the drill pipe.

For data on other methods of welding tool joints and other profitable applications of arc welding in the oil fields, consult the nearest Lincoln office or mail the coupon.

THE LINCOLN ELECTRIC CO
Dept.AC-631, Cleveland, Ohio

Send free bulletin ☐ Welding of Casi
☐ Pipe Line Welding. ☐ Welding
Tool Joints. ☐ Welding Procedure Guid

Name _____

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Company _____

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LINCOLN SHIELD-ARC WELDING

PRODUCES A STRONGER, MORE LASTING CONSTRUCTION FASTER, AT LESS COST

7 ANSWERS

as experience proved which steels re most economical and suitable for rill Collars and Kellys?

heat treatment of the *entire* prodct really of vital importance?

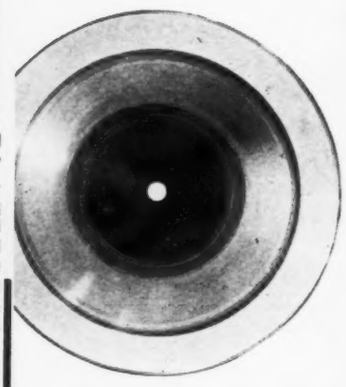
oes precision alignment of the joints dd to the life of Drill Collars and ellys?

it possible to bore a *straight* hole hrough a Drill Collar or Kelly 40 feet more in length?

oes it pay to insist upon "concenicity of bore"?

it necessary to give a third heat eatment to the joint ends of a Drill ollar or Kelly?

an Drill Collars and Kellys that ossess all the desirable features ientioned above be purchased at easonable prices?



you are looking through a 40-foot h-Ross Drill Collar. Here is "conicity of bore" that pays dividends n table speeds are high.

ALL YES!

1YES —Several major oil companies have proved by drilling many thousands of feet that S.A.E. X3140 Nickle Chromium Steel or S.A.E. 4140 Chrome Molybdenum Steel, are the most suitable materials.

2YES —Heat treatment *over the entire length* in one operation is needed to remove strains produced during forging and straightening operations, and to produce and increase uniform physical properties. A second heat treatment over the entire length is recommended, after turning and boring, to remove any residual strains, and further to improve physical properties.

3YES —If the ultimate in economical and trouble-free service is desired, the maximum misalignment between the axis of the threaded joints at each end should not exceed ½" in 40 feet, checked by surveying from joint to joint.

4YES —You can secure either Drill Collars or Kellys 40 feet or more in length having a tolerance in bore diameter of plus 1/32"—minus 0" with a variance in wall thickness less than ¼"—and yet so straight that a test bar 10 feet long and not less than ⅛" smaller than the specified bore will pass through freely and without binding.

5YES —And this is particularly true since the speed of rotation of the drilling string has been greatly increased. It is readily understood that if the "concentricity of bore" is not held to extremely close tolerances, the Drill Collars will be definitely out of balance. The hazards of the resultant "whip" when high rotation speeds are employed, need not be explained to any experienced operator.

6YES —In addition to twice heat treating over the entire length, the ends should be heat treated a distance of several feet to secure a hardness of 277-302 on a Brinell Hardness Testing Machine. The maximum toughness thus developed is a vital part in the manufacture of successful, modern Drill Collars and Kellys.

7YES —Practically every feature is present in *all* Baash-Ross Drill Collars and Kellys which sell at the same prices as ordinary products. The nominal extra charge made for the second entire heat treatment is completely absorbed by the greatly increased life in service... Ask the office nearest you to present the full story of Baash-Ross TRUBORE Drill Collars and Kellys... They can help cut your drilling costs. YES, that's a promise.

YES, these Baash-Ross craftsmen are proud of a Kelly that is 54 feet in length, with a 4½" bore, and that meets the most exacting specifications ever established.

BAASH-ROSS

D C L C P N

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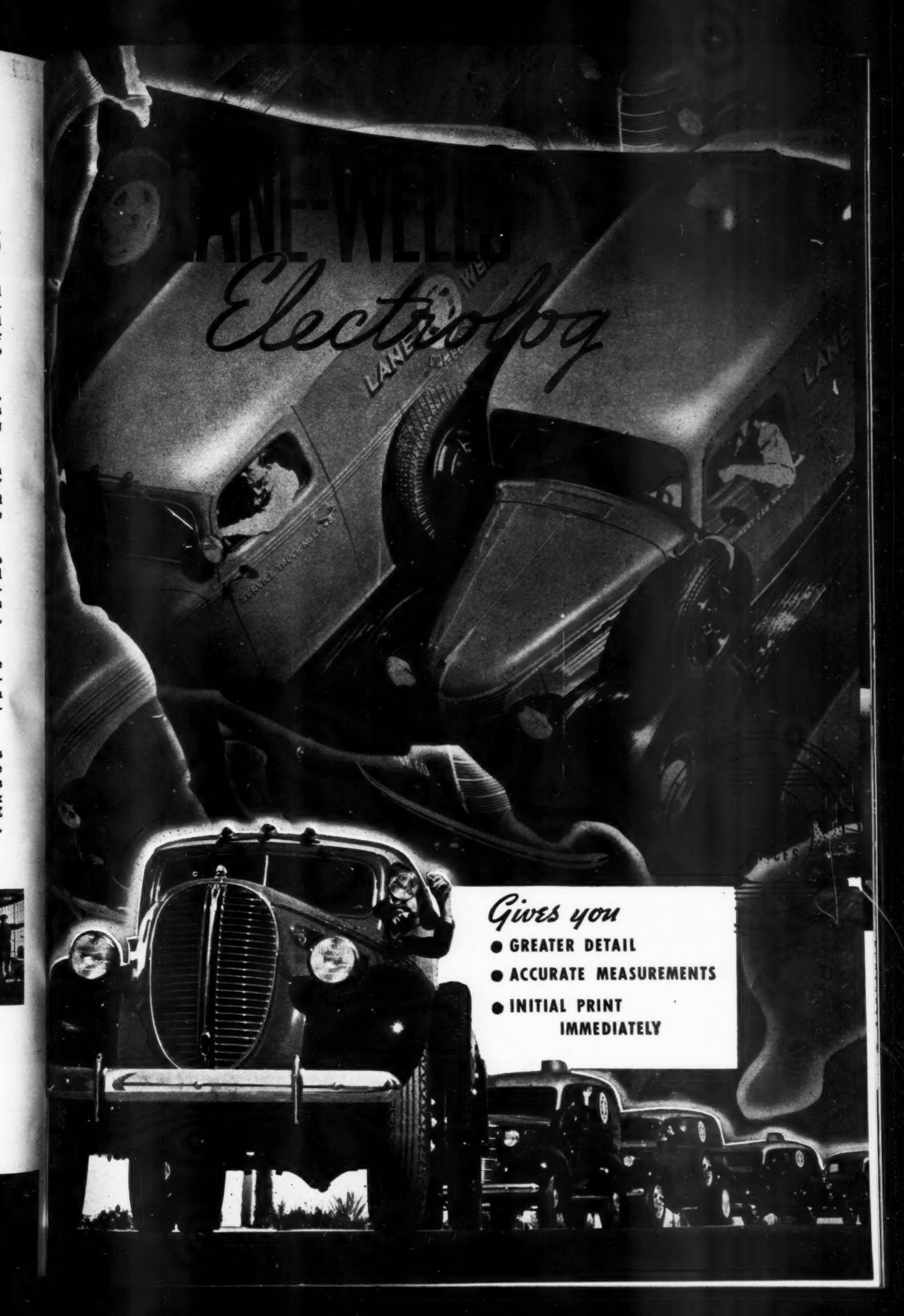
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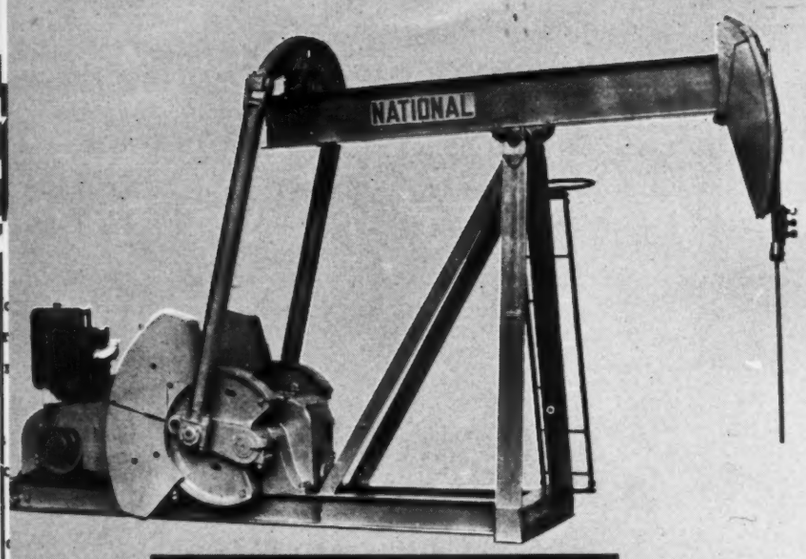
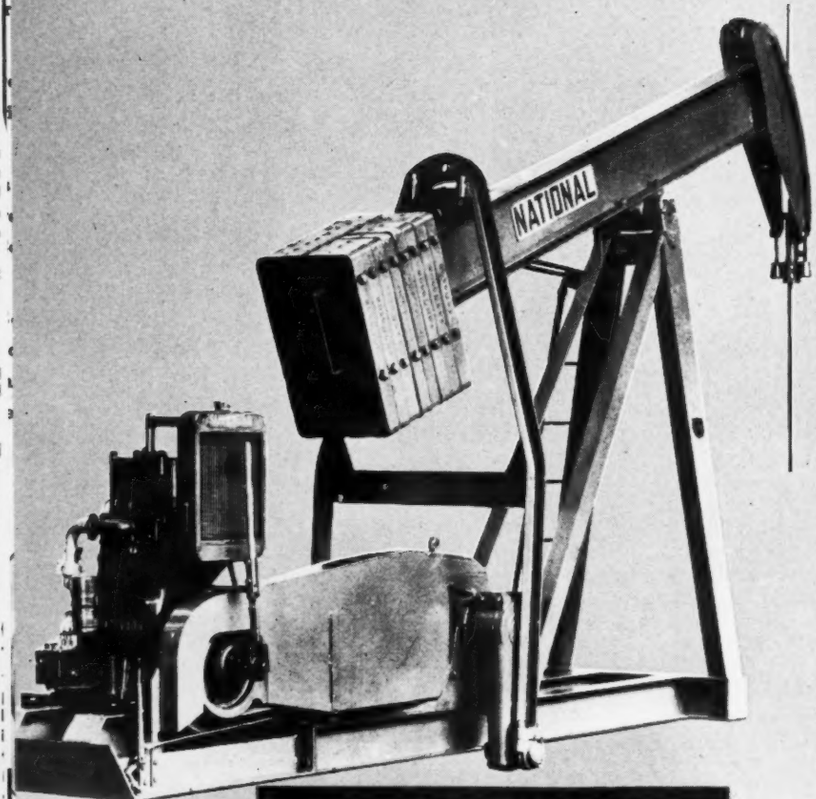


Type TU234-JD23TB



Type TU234G-JD23TP

TWO NEW NATIONAL UNIT PUMPERS

The Type TU234-JD23TB NATIONAL UNIT PUMPER offers at a moderate cost the same general features as the larger National Unit Pumpers, including National Eccentric Disc Cranks and Counterweights and equalized pitman assembly.

The Type TU234G-JD23TP NATIONAL UNIT PUMPER offers at a lower cost the same capacity and features as the Type TU234-JD23TB Unit Pumper above except that plain cranks, beam counterweights and unitary pitman assembly are used.

BRIEF SPECIFICATIONS TYPES TU234-JD23TB and TU234G-JD23TP	
API safe load of walking beam, pounds	9125
Polished rod strokes	27, 34½, 42
Peak torque rating at 20 spm inch pounds	57200
Overall reduction ratio	29.8

NATIONAL

THE NATIONAL SUPPLY COMPANY

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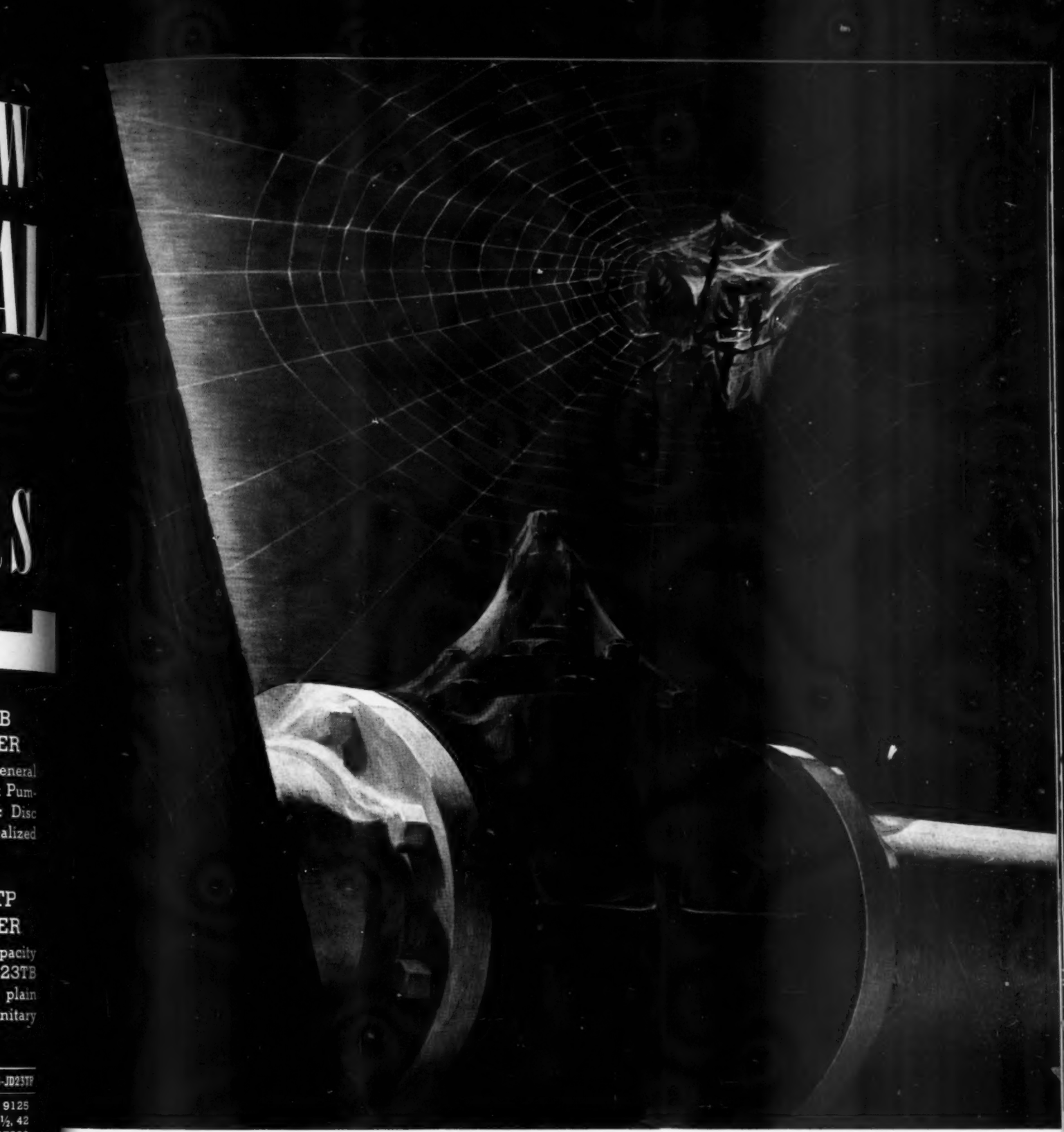


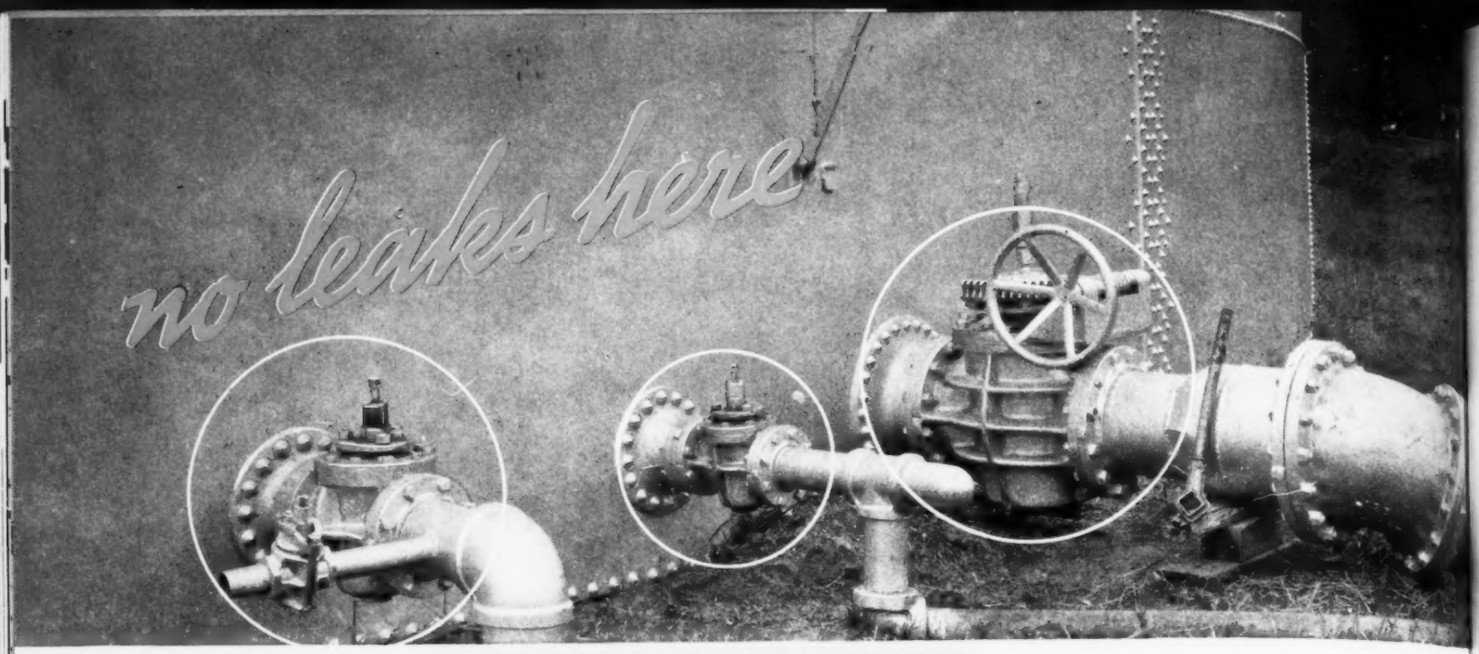
NORDSTROM VALVES *on Cobweb Lines*

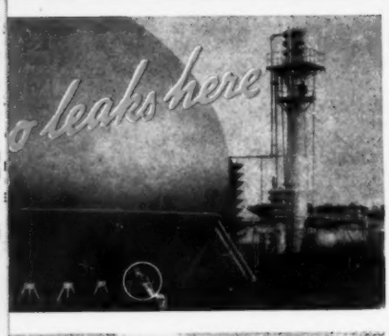
always instantly ready to spring into action

Seldom-valved lines, "freighted with cobwebs," so-to-speak, can harbor danger and trouble. Suppose the valve is frozen tight by corrosion, erosion or otherwise —and you have to open or close it quickly. What then?

¶ No such predicament confronts you when your lines are equipped with Nordstrom Valves. They can "go for years" without turning, but are ready for instant action at any critical moment. This safety factor is particularly significant on gas lines, gasoline lines, ammonia lines, pipe lines and numerous emergency lines.

¶ *Patented "Sealdport" lubrication is the protective principle; it insures easy valve operation at all times.*





MERCO NORDSTROM VALVE CO.

A Subsidiary of PITTSBURGH EQUITABLE METER CO.

WORLD'S LARGEST MANUFACTURERS OF LUBRICATED PLUG VALVES; GASOLINE, OIL & GREASE METERS

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PRODUCTS: Nordstrom Plug Valves • Nordstrom Air, Curb and Meter Cocks • Nordstrom Valve Lubricants • EMCO Gas Meters • EMCO-McGaughy Integrators • EMCO Regulators • Pittsburgh Meters for Gasoline, Grease, Oil, Water and other Liquids • Raybould Couplings • Stupakoff Bottom Hole Gauges

ORSTROM VALVES

WITH PATENTED "SEALDPORT" LUBRICATION

Only Nordstroms meet every major valve need

STRONG ENOUGH TO DO THE JOB
SMOOTH ENOUGH TO DO IT WELL

AMERICAN
SUPER-HEAVY-DUTY
ROLLER BEARINGS

These "Americans" are SUPER Heavy-Duty Bearings, so they have more reserve strength than is necessary to bear any loads demanded of drilling equipment. Obviously, however, oil-field tools require more from a bearing than strength alone. American Super-Heavy-Duty Roller Bearings give you, in addition, the ***absolute precision*** you need to keep heavy-duty equipment running smoothly and flawlessly, no matter what severe demands are placed upon it. Our engineers invite your consultation on any roller-bearing application.

AMERICAN ROLLER BEARING CO.
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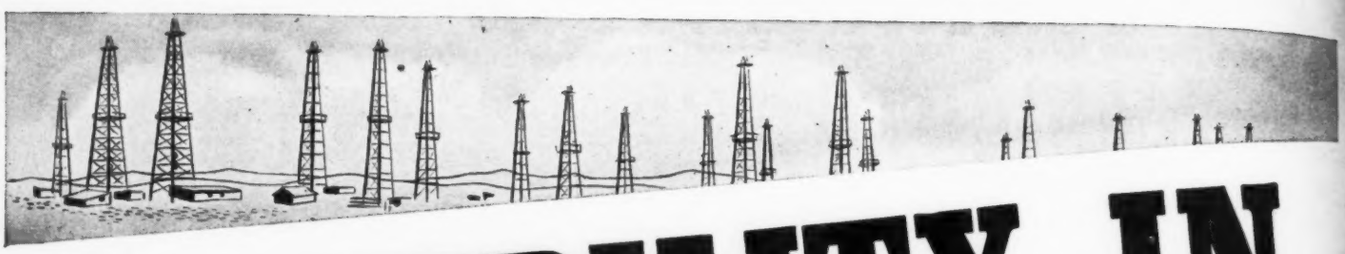
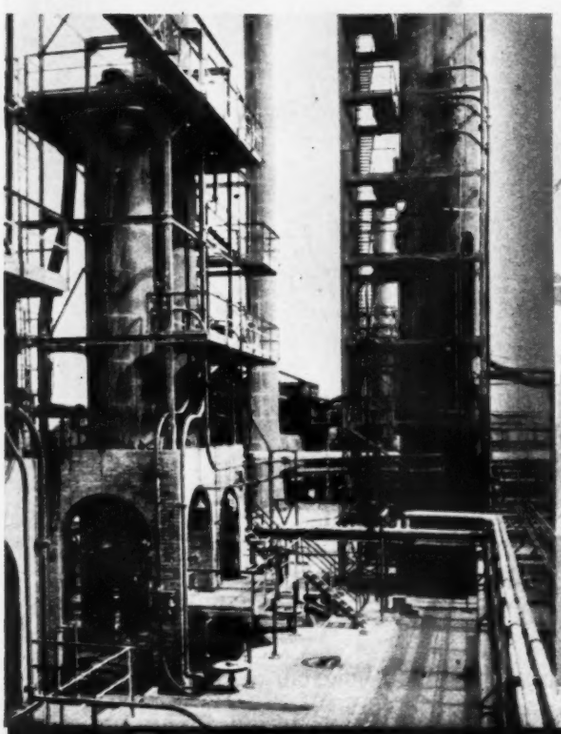
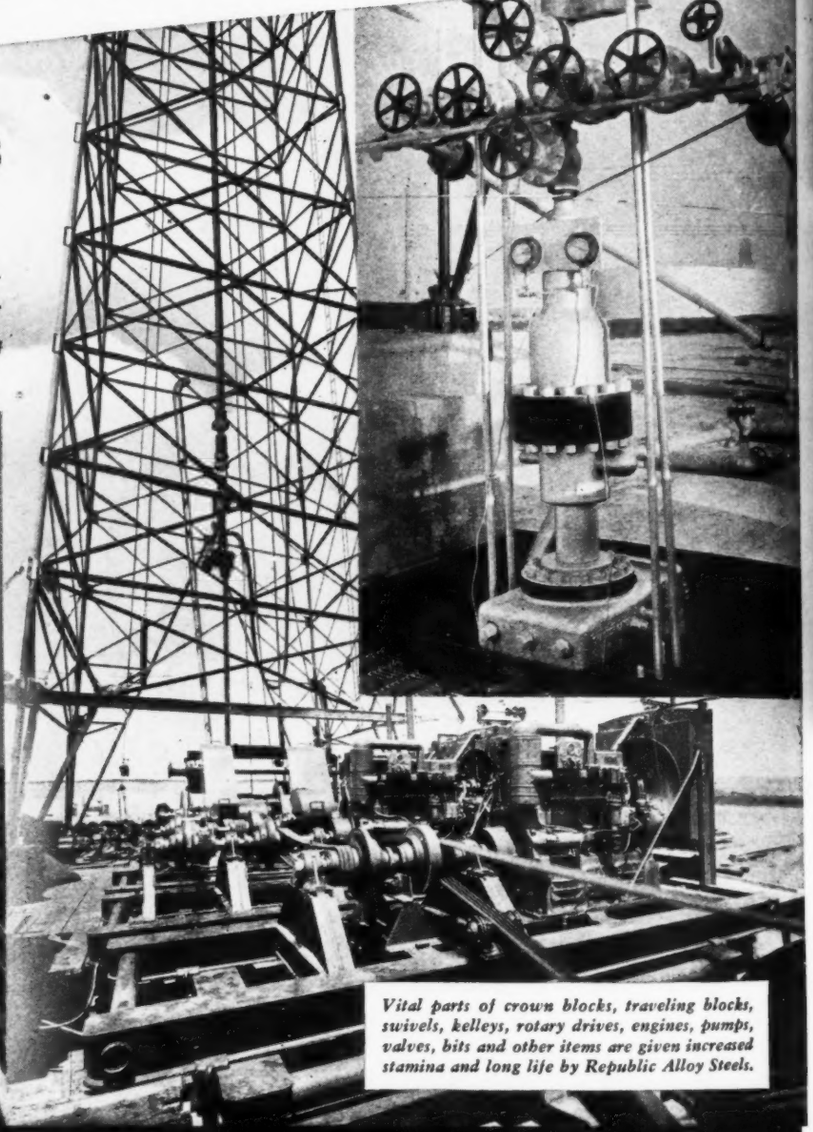


FLEXIBILITY IN

Attributes of Alloy Steels

1. Flexibility—a steel for every application.
2. High physical properties.
3. Improved efficiency in large sections.
4. High fatigue qualities.
5. Heat-resistance—high creep strength.
6. High strength of welds.

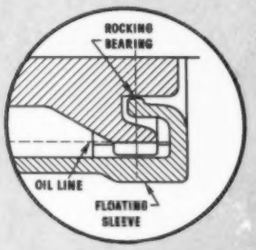




Vital parts of crown blocks, traveling blocks, swivels, kelleys, rotary drives, engines, pumps, valves, bits and other items are given increased stamina and long life by Republic Alloy Steels.

REPUBLIC

When writing REPUBLIC STEEL CORPORATION *for further information, please address Department PT.*



THESE COUPLINGS BUILT THEIR REPUTATIONS ON TOUGH JOBS

Service on drilling rigs puts flexible couplings on the spot. Failure may cause delay that costs thousands of dollars. Couplings have to deliver, regardless of conditions.

Service on drilling rigs gave Fast's Self-aligning Couplings their reputation with practical oil men. Time after time, under all sort of conditions, Fast's have proved that they can *take* it . . . and *last.*

Cure your coupling troubles just as others have—specify genuine Fast's Self-aligning Couplings on the equipment you purchase. KOPPERS COMPANY, BARTLETT HAYWARD DIVISION, Baltimore, Maryland.

This sectional drawing shows Fast's con struction. The load-carrying surfaces ar protected from wear by a positive film o oil. This oil is kept permanently clean b the rocking bearings, which make precis metal-to-metal contact forming permanen dust and moisture-proof seals. There are n perishable parts, grids, laminated plates o laminated pins . . . nothing to wear out . . nothing to need attention other than oiling

FAST'S COUPLINGS

a KOPPERS product

NO. 9 OF A [illegible]
SHOWING [illegible]
SECURALOY
INCREASED
DEVELOPMENT
EFFICIENCY

SE THIS SECURALOY CABBING* ASSEMBLY OR *Safe* REPAIRS!

ASIONALLY operators are confronted with the problem of ring a damaged section of casing to exclude water... or it nd necessary to seal off certain undesired perforated liner een sections... or one or more leaky casing joints must be red. For this type of work, the SECURALOY "Scabbing" nbly (placing pipe sleeve within an existing liner or casing) equalled. It is easy and positive to set, requiring only one nto the well... it forms a tight permanent seal top and bot-.. it may be cemented in place, if desired... and, being of SECURALOY, *it can be completely drilled up and cir-ed out of the well whenever necessary.*

SEALS TOP AND BOTTOM

e Security Drillable "Scabbing" Assembly is essentially a n of SECURALOY Pipe (the length depending upon the ace to be sheathed) with a *drillable* packer at its upper and ends.

ower packer is similar to a Security Drillable Slip Type er with packing elements, except it is threaded at the top d of the bottom to accommodate the pipe sleeve section. ugh the "Scabbing" sleeve ordinarily is blank pipe, it may e-perforated to any desired mesh should it be desirable to a secondary screen placed inside of damaged slotted pipe een.

urity Packing Type Hanger with reversed slips is attached top of the "Scabbing" Assembly and, when located in its r position, the packing is expanded with a Security De-l Action Packer.

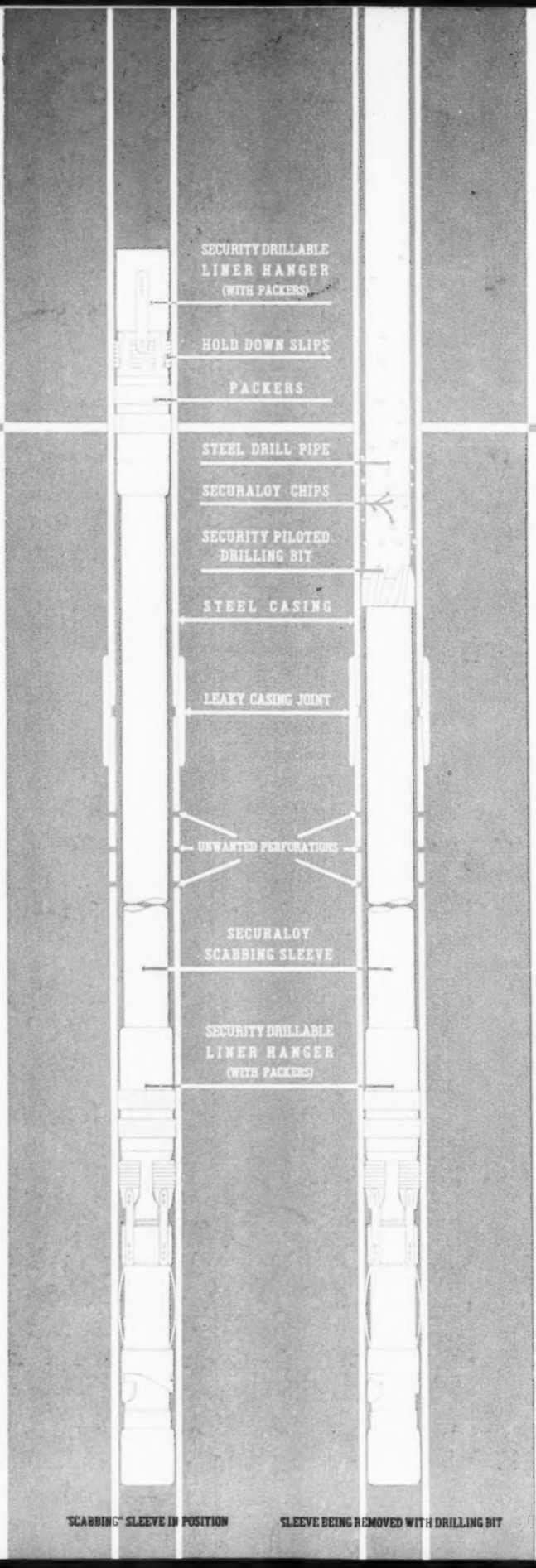
ONLY ONE TRIP REQUIRED

ly one trip into the hole is required to lock the sleeve firmly ce and expand both the top and bottom packers. The unit is ed into the well on a Security Left Hand Releasing Tool pped with Delayed Action Device) and when the desired is reached, the slips on the bottom packer are set and the ng seal expanded in the conventional manner. Then the run-ing is backed off and lifted a short distance, thus placing elayed Action Setting Device in operating position so that, e weight is again lowered, the upper packing seal is packed The operation is as simple as that—and note that each er is expanded separately under individual control!

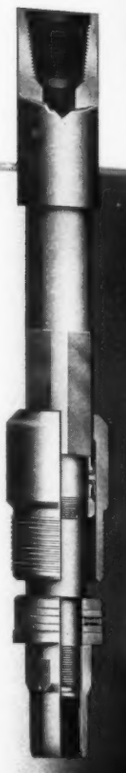
hould be desired to cement the sleeve in place, this can be nplished readily by using suitable cementing equipment. *cementing operation does not necessitate an additional trip he well!*

details on the uses of this "Scabbing" Assembly will be sup-by our Engineering Department upon request.

ABBING" is the operation of sealing over a defective or un-ed perforated section of casing.



"SCABBING" SLEEVE IN POSITION — SLEEVE BEING REMOVED WITH DRILLING BIT



● The Security [illegible] Releasing Tool [illegible] Delayed Action [illegible] (below), and the [illegible] and Delayed Action [illegible] ers illustrated at left are all described in the [illegible] Drilling Equipment Directory and the 1939 Composite Catalog. Descriptive folders on these items are available on request.

SECURITY ENGINEERING CO., INC.

WHITTIER, CALIFORNIA • PHONE 42004

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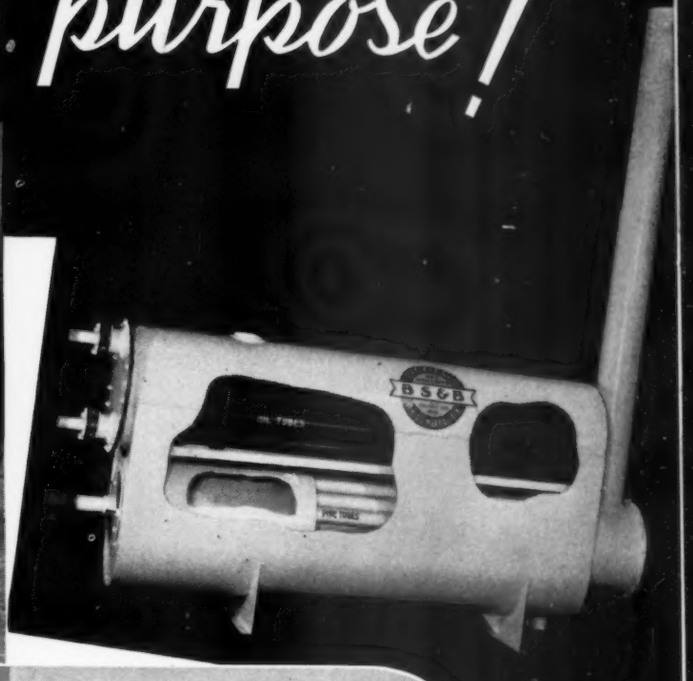
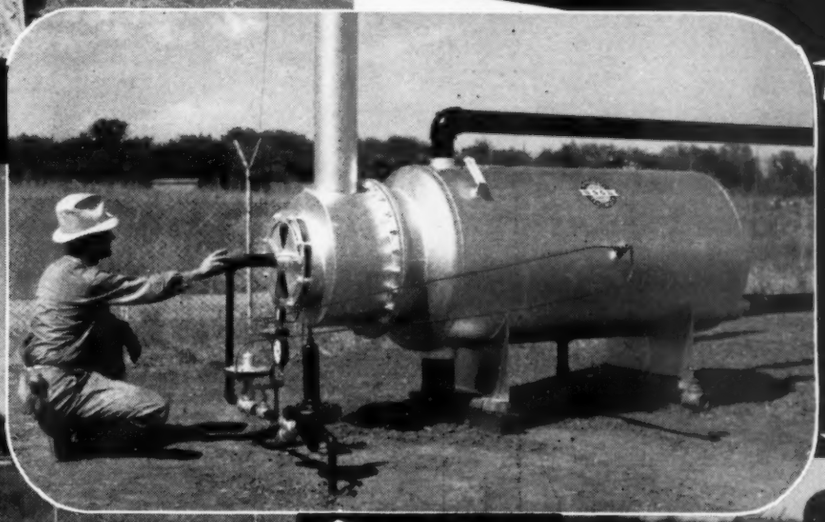
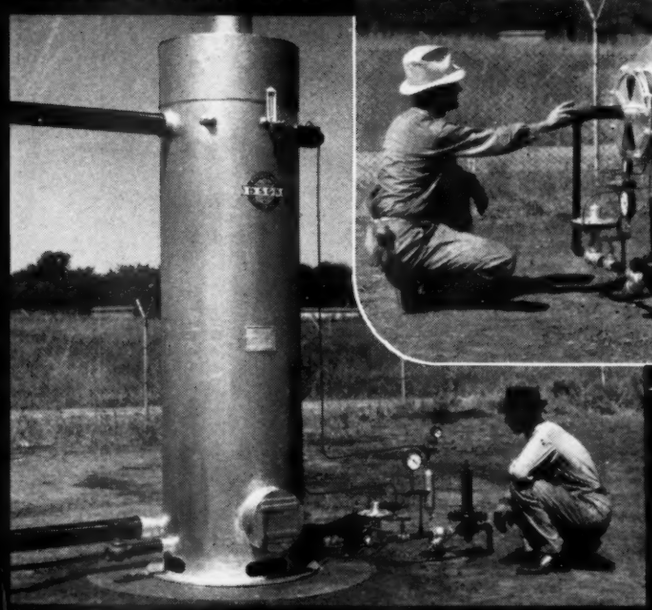
The B.S.&B. Tubular Treating Heater. Highest Efficiency —Steel or Cast Iron Tubes.



The B.S.&B. Ind Heater. Will Scorch — Low Even Heat Minimizes Corros



The B.S.&B. Horiz Fire Tube Heater. L Settling Spac Low Cost.



The B.S.&B. Vertical Treating Heater Small Sized — Cheap

The B.S.&B. Internal Firebox Heater. Easily Renewable Firebox—Portable —High Heating Capacity.

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Black, Sivalls & Bryson

(INC.)

OKLAHOMA CITY

WHEN THE INDUSTRY TALKS—

IT PAYS TO LISTEN

LOS ANGELES BASIN

"... Squeezing cement through shot perforations to cement off water entry from above and below a producing horizon, is only one of the successful applications we have found for the Baker Cement Retainer here in the Basin."

SAN JOAQUIN VALLEY

"... So we used a Cement Retainer to do a multiple batch squeeze job around the shoe ... water was coming in from above ... and we got a perfect shut-off."

ILLINOIS BASIN

"... Yes, and we also use it very successfully to perform squeeze jobs on casing leaks."

MID CONTINENT

"... We found that plugging back is no problem with the Baker Cement Retainer method."

LOUISIANA

"... Sure we had bottom water trouble on No. 2, but not after we did that squeeze job with a Baker Cement Retainer."

ROCKY MOUNTAIN TERRITORY

"... Of course you can use that Baker Cement Retainer for a Casing Bridge Plug ... and it makes a mighty efficient one, too."

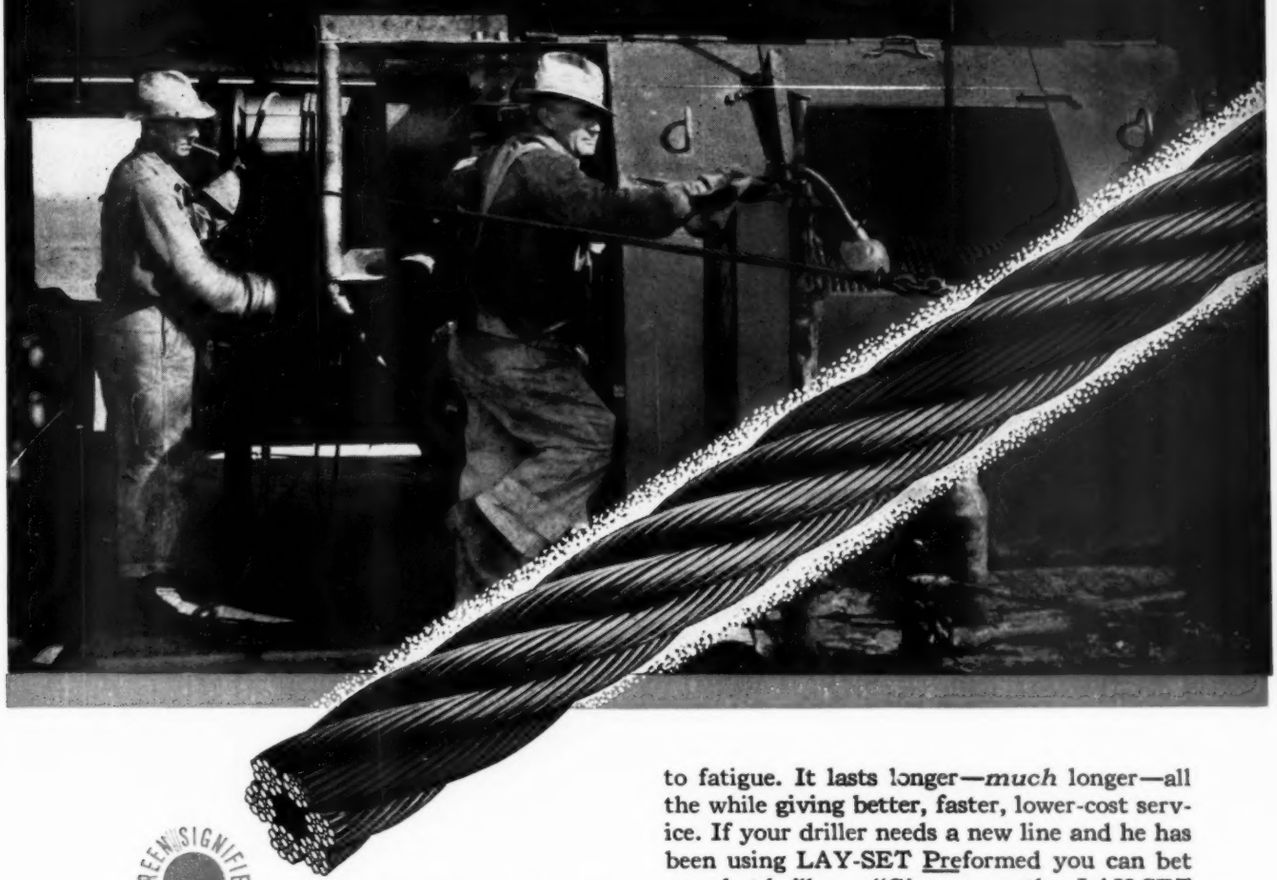
TEXAS

"... And by squeeze cementing we reduced the gas/oil ratio from 26,300:1 to 366:1 ... and the Baker Cement Retainer functioned perfectly."

COMPLETE DETAILS concerning the Baker Cement Retainer and its many important applications are given in Baker Broadcast No. 17-A. A copy of this comprehensive 40-page treatise will gladly be sent upon request.

BAKER OIL TOOLS INC., Box 71, Huntington Park, California

LAY-SET *Preformed* MAKES FASTER ROUND TRIPS



GREEN SIGNIFIES SAFETY

Right now these men aren't thinking of their rotary line. They are busy adding a joint of pipe. But they *would* think of it (profanely) if it whipped so hard they had to slow down when returning the idle block—or if it piled up on the drum.

Hazard LAY-SET Preformed is the rotary line that is free from those faults and thereby permits faster round trips. But not only does it run smoothly and spool perfectly but being carefully preformed, it has amazing resistance to fatigue. It lasts longer—*much* longer—all the while giving better, faster, lower-cost service. If your driller needs a new line and he has been using LAY-SET Preformed you can bet your hat he'll say: "Give me another LAY-SET Line." And that's one thing about LAY-SET Preformed—every line *is* of the same uniformly high quality. All Hazard wire lines made of Improved Plow Steel are Identified by the Green Strand.

BUY ACCO QUALITY *whether for Hazard Drilling Lines—American Welded and Weldless Chain—Wright Hoists—Page Chain Link Fence—Page Welding Wire—Reading-Pratt & Cady Valves or any of the other 137 ACCO Quality Products.*

Write today for this free booklet. You'll find it constructive and helpful.

HAZARD WIRE ROPE DIVISION • *ESTABLISHED 1846* • **WILKES-BARRE, PENN.**

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AMERICAN CHAIN & CABLE COMPANY, Inc.

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HOWCO CO-AXIAL SPIRAL

A LITTLE TRIANGLE OF RUBBER provides a performance-proved answer to two major problems: (1) thorough distribution of cement at critical points behind casing, and (2) centralization of casing at those points . . . Always important, these problems are emphasized when production strings of casing are set through several producing sands and then selectively perforated . . . The solution—HOWCO CO-AXIAL SPIRAL—consists of a triangular section of rubber vulcanized to a metal strap base which is attached to outside of casing by welding at intervals. It eliminates concern as to whether cement is properly distributed around the casing where such distribution is vital to the successful completion of the well. See your Composite Catalog.

HALLIBURTON OIL WELL CEMENTING COMPANY